MACHINERY

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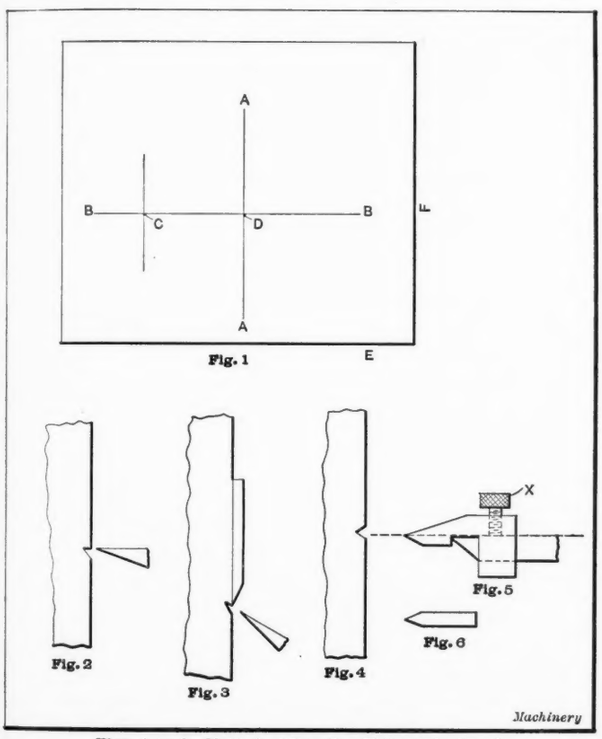
A NEW SYSTEM FOR LOCATING HOLES TO BE BORED ON THE MILLING MACHINE

By GEORGE J. MURDOCK*

THE problem of accurately locating holes to be bored on the milling machine has received much attention, as this machine is the only one on which a large class of work can be done correctly and rapidly. The method generally used where accuracy has been required is known as the "button system." This consists in locating the holes by a device known to toolmakers as a button, which is located for the first hole from a base line, while for subsequent holes the buttons are located by micrometer measurements between the buttons. The work, with the buttons on it, is then placed upon the milling machine table, and indicated from the axis of the spindle until the axis of the button coincides with it, when the hole is bored. The cost of doing the work by this method is so great, however, that numerous efforts have been made to achieve equally good results in other ways, many of which have been tried, but most of which have developed such objectionable features in practice that their use has been limited.



Figs. 1 to 6. Method of Locating Holes to be bored

The increasing demand for rapidity coupled with accuracy, with a minimum liability of error, led the writer to develop the system described in this article, a center-punch mark taking the place of the button from which to indicate the work into the proper position for boring. The fundamental principle involved is to lay out, accurately, two lines at right angles to each other, and correctly centerpunch the point where they intersect. With proper care lines may be drawn with a vernier height gage at right angles, with extreme accuracy, the chief difficulty being to accurately center the lines where they cross. Casual consideration may make this appear easy with the common center-punch, and with semi-accurate work this may be done; but where extreme accuracy is required this method is not applicable, as the hand and the eye of the average man, at best, is incapable of marking the correct location closer than 0.001 inch.

Fig. 1 illustrates in a simple way the procedure adopted in laying out work by the new system. The base *E* is in contact with the surface plate while the line *B–B* is drawn with a height gage. Side *F* is used on the plate while drawing the line *A–A*. It will be seen that these lines will be at right angles to each other if the bases *E* and *F* are correct. Work done by this method must have two working surfaces or base lines, and these must be at right angles to each other. There is no particular difficulty in drawing the locating lines *A–A* and *B–B* correctly, either with a vernier height gage or with a special micrometer gage reading to tenths of thousandths (0.0001) inch, the only difficult element being to accurately centerpunch the lines where they intersect as at *D*. It is assumed that two holes are to be bored, so that the intersection at *C* would also be centerpunched.

An analytical consideration of the conditions will illustrate the importance of beginning the work correctly. Fig. 2 shows on an enlarged scale the line made by an ordinary vernier height gage. Resembling, as it does, a saw tooth, it is clear that if two such lines are drawn at right angles as shown in Fig. 1, it would be impossible to so centerpunch them where they cross at *D* that the mark would be exactly at the center of the intersection of the lines. It would be quite incorrect,

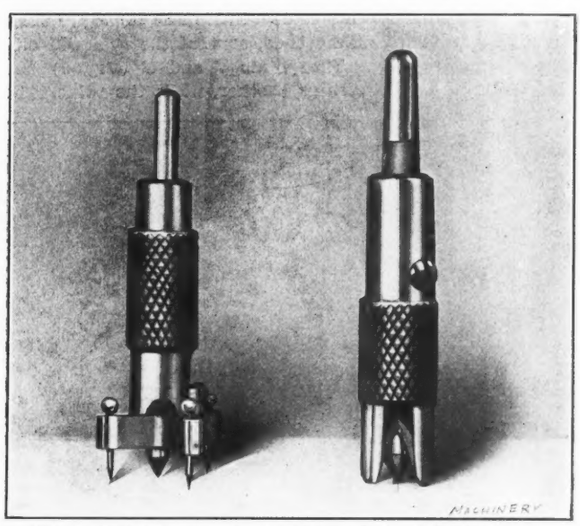


Fig. 7. Center Locating Punch Fig. 8. Center Enlarging Punch

and no matter how carefully indicated, the resulting hole would be also inaccurate. Fig. 3 shows this type of line as drawn with a scriber along a straightedge, and two lines of this character drawn at right angles would produce a condition at *D* (Fig. 1), still worse than that caused by those drawn by the vernier height gage. In Fig. 4 is shown the correct contour of line to use with this system, while Fig. 5 illustrates the scriber attachment for the ordinary vernier height gage to which the scriber, Fig. 6, is secured by the set-screw *X*.

As it is quite or almost impossible to accurately centerpunch the intersection of even two correctly drawn lines by any means heretofore known, the punch shown in Figs. 7 and 9 has been evolved, and an extended experience with it on a very high grade of work has demonstrated its value for the purpose. It consists essentially of a small centerpunch *O* held in an exactly vertical position by a holder *P* which is knurled to facilitate handling. Great care should be exercised in

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making this tool to have the body of the punch straight, and to have it stand correctly in the holder, at right angles to the surface to be operated upon, for the slightest inclination will cause the finished hole to be incorrect, no matter how carefully the lines are drawn. The 60-degree point must be ground correctly with the axis. The holder for the punch stands on three legs, located as indicated, and ground accurately to a

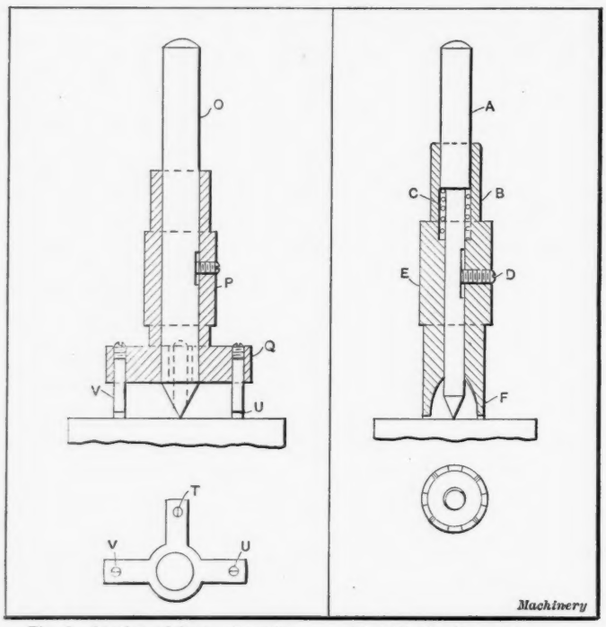

Fig. 9. Section of Center Locating Punch

Fig. 10. Section of Center Enlarging Punch

taper that fits in the holder, where they are secured by watch screws bearing on their tops. The lower ends are hardened, and terminate in an angular point of 55 degrees (the point of the vernier scriber being 60 degrees). The edges are sharp, and slightly rounded at the ends, so that the legs will slide along a line smoothly. The points *V* and *U* (Fig. 9) have edges that are in line with each other, while the point *T* has

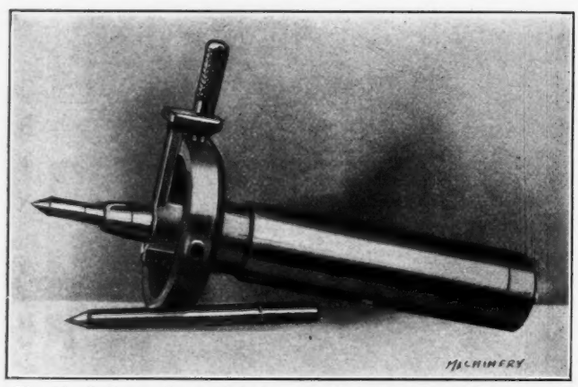

Fig. 11. Indicator Assembled; Long Centering Rod in the Foreground

an edge at right angles to the other two. The center of the punch is located at equal distances from all the legs, and is held off the work normally by a leather friction acted upon by a set-screw in the side of holder *P*.

If this tool is placed upon lines of the character shown in Fig. 4 (which for the purpose of this description will be assumed to be drawn on a block of metal, Fig. 1, in which holes are to be bored), the legs *V* and *U* may be slid along line *B–B* until the sharp edge of leg *T* drops into line *A–A*. When this occurs the punch *O* is lightly tapped with a hammer, and the resulting mark will be accurately located in the center of the intersection of the lines. It is the practice of the writer to make the work very smooth before drawing the lines, and after laying them out, to stone them so as to remove the slight burr raised in drawing them. A drop of oil is then rubbed into the lines, and the surplus wiped off. This procedure permits points *V* and *U* to run very smoothly along the line, and the burr having been removed, the edge of leg *T* drops into the line very readily with a slight click. As it is not advisable to strike punch *O* more than a very light blow, it marks the work but slightly, and a more distinct indentation is made with the follower punch shown in Figs. 8 and 10. This is made like the previous one so that it will stand perfectly at right angles to the work. The sectional view (Fig. 10) shows the punch *A* supported by the holder *E* which has four legs *F* cut away on the sides so that the point of the punch may be seen. When this punch is in position, it is struck a sufficiently heavy blow to make a distinctly visible mark. The work is now ready to be placed upon the work table of the milling machine, and indicated for boring the holes, an indicator being used in the milling machine spindle.

An indicator which has been found especially valuable for this purpose is shown in Figs. 11 and 12. The only requirements are that the milling machine spindle be in good condition, and that the indicator be accurately made. It is of the concentric centering type, and with it the work is brought concentric with the axis of the spindle. The arbor *I* is provided with a threaded nose on which disk *D* is screwed. This disk has four holes in its rim, equally spaced from each other. Hardened, ground, and lapped bushings *b* are put into these holes to receive plug *A* which is made a gage-fit both in these

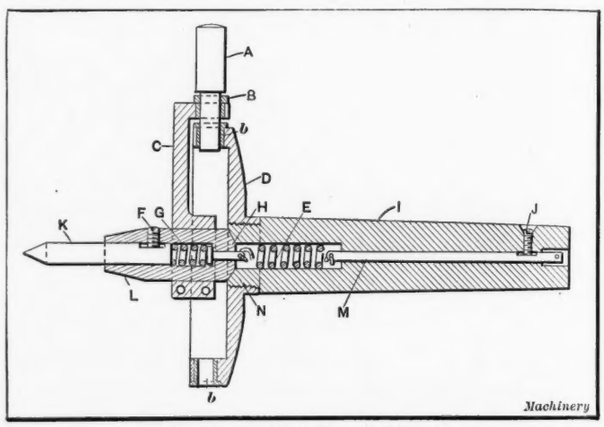

Fig. 12. Sectional View of Indicator

holes and in hole *B* in the outer end of sector *C*. This sector is held by a split sleeve to the barrel *L* which carries the 60-degree centering-rod *K* that comes into contact with the work to be bored. The latter, of course, is secured to the work table. The spherical base of barrel *L* fits into a corresponding concave seat in the nose of the arbor at *H*, and is held in place by a spring *E* which connects at one end to the cylindrical stud in the base of the barrel, and at the other to the axial rod *M* by which it and the other connecting parts may be drawn into place, and held by the headless set-screw *J*, bearing on a flat spot on the tang end of the rod.

Fig. 13. Parts of the Indicator

Fig. 14. Sector, Plug and Centering Punch

Now, if plug *A* is removed from bushing *b* the point of the centering-rod *K* may be made to describe a circle. At some point within this circle is located the center-punch mark on the work to be bored. The holes in the rim of the faceplate all being exactly the same distance from an axial line through both the arbor *I* and centering-rod *K*, it follows that the center mark on the work must be so located by horizontal and vertical movements of the work table that pin *A* may be freely entered in all the four holes in the rim of disk *D*. When that occurs, the center coincides with the axis of the spindle.

The point of the center-punch *A* (Fig. 10) should have an angle slightly greater than the angle on the centering-rod *K*, as it is impossible to locate the work in the preliminary trials so that the center of the work will be coincident with the axis of the spindle, and unless the precaution mentioned is taken, the true center on the work is liable to be drawn from its proper location when trying to bring the work into such a position that the plug will enter all the holes in the disk. As the work being operated on is brought nearer to the proper location by the movements of the milling machine table, spring *G* will be compressed, the center rod sliding back into barrel *L*. This spring is made so that it will hold the center against the work firmly, but without interfering with the free rotation of the sector *C* around disk *D*. When the work is located so that the plug enters the holes, the gibs of the machine should be tightened up and the plug tried once more, to make sure that the knee of the machine has not moved sufficiently to cause the work on the table to be out

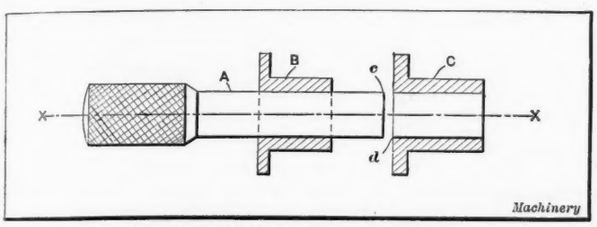

Fig. 15. Detail View of Plug and Bushings

of line. The work table is now clamped to prevent accidental horizontal shifting, and the work is drilled and bored as in common practice.

In using this indicator the milling machine spindle is not rotated together with arbor *I*, only the sector being turned around the disk. The tool is so set, however, in the beginning, that the axes of two of the bushings *b* would be at right angles to the horizontal plane of the machine table, while the axes of the other holes in the disk would be parallel with the top of the work table. The plug *A* projects outwardly at right angles to the spindle, and is therefore out of the way of the work on the table of the machine. The centering-rods are made interchangeable and of various lengths, to reach more or less easily accessible centers. Fig. 11 shows the indicator with one of the long center-rods in the foreground.

One of the desirable features in a tool of this class is compactness and capability of being easily packed in the tool-chest. Fig. 13 shows it taken apart, and it is so designed that the calibration is correct when it is again assembled.

It is plain that the question of "feel" would enter largely into the use of the indicator described, if the tool were incorrectly constructed, as, for example, if the hole in bushing *C*, Fig. 15, were slightly bell-mouthed, or if plug *A* were tapered. In making these, however, care is taken to have the plug, as well as the holes in the bushings, precisely the same diameters at both ends. The edge *c* of plug *A*, as well as bushing *C* at *d* are square and sharp. If plug *A* were either tapered or slightly rounded at *c* it might be forced into the bushing, in which case the "feel" would be an important factor. The plug, however, cannot enter the bushing *C* until both bushings and plug coincide axially with the line *X–X;* and when the milling machine table is so moved that this can occur, it is not possible to distinguish any difference between the fit of the plug whether the centering-rod is in contact with the work or away from it.

While this indicator has been specifically described for use with the milling machine, it may be used also to set the tail-stocks of lathes central with the headstocks. A female center is put in the headstock, and only the horizontal holes in disk *D* are used. Work may also be located for boring on the lathe faceplate (after the lathe has been "centralized"), and accurate results obtained by following the system described in this article.

On some classes of work buttons may be preferred, and micrometer measurements made. In such cases a sleeve provided with a center is slipped over the button after it is located. This indicator may then be used to bring the work into the proper position to be bored with comparative ease and rapidity. The only part of the milling machine on which dependence must be placed for accuracy is the hole in the spindle, and this is less liable to get out of truth, from wear such as would impair the accuracy, than are the knee, table, or micrometer screws. The only moving part is the sector, and this, being light, is very sensitive.

A series of 24 holes was recently laid out and bored in one and one-half day. Measurements with lapped accurate plugs in the holes showed the greatest deviation from truth to be 0.0002 inch, and running from that to accuracy so great that no error was measurable. This same work with buttons would have required at least one week, and with results no better, if as good.

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ADHESION OF SWEDISH GAGES

A remarkable property of the so-called Swedish gages is their adhesiveness to one another. When wrung together they will resist separation in a direction at right angles to the faces in contact, with a force considerably greater than the atmospheric pressure on the area of contact. This phenomenon has caused some to believe that actual molecular adhesion takes place when surfaces that are nearly perfect planes are brought into intimate contact. Tyndall, the eminent English physicist, reached the conclusion thirty-five years ago that molecular attraction was partly the cause of the phenomenon.

The error of this theory has been shown by some recent investigations of H. M. Budgett, reported to the London Royal Society, showing that the adhesion results from the presence of a very thin liquid film. Some blocks of hardened steel were prepared, each weighing an ounce and a half and having surfaces of 0.7 square inch polished flat to within a millionth of an inch of accuracy, and these were used to test the adhesive properties of many liquids. The contact faces were carefully freed from moisture and grease with alcohol before being smeared with a very thin film of the liquid under test. On wringing together perfectly clean they fell apart under their own weight; but blocks held together by films required to separate them, a force ranging from seventeen pounds for Rangoon oil, to twenty-two for lubricating oil, twenty-nine for turpentine, and thirty-five for condensed water vapor. After washing the hands with soap, blocks rubbed on them showed adhesion as high as ninety pounds. There was no adhesion from volatile liquids, like alcohol and benzine; and very little from viscous liquids, such as glycerine and glucose.

The microscope showed that the films, drawn out in thin lines, covered only a tenth or less of the metal faces. From varied experiments it appeared that in the case of paraffine film, for instance, the twenty-seven pounds required to part the plates included about one pound due to atmospheric pressure, one to surface tension and twenty-five pounds to the actual tensile strength of the liquid. The tensile strength of water seemed to be as high as 443 pounds per square inch!

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THE ENGINEER'S PLACE IN MUNICIPAL AFFAIRS

The government of cities and municipalities presents some of the most difficult problems that confront American citizens. The lack of central authority and responsibility as well as the common lack of efficient supervision and coordination of the work of departments inevitably lead to deplorable waste and confusion. Gen. Bingham, former police commissioner of New York City and now an official in its department of bridges, in a recent talk to the Swedish Engineers' Club of Brooklyn, attributed much of the trouble to the common misconception that business men are best qualified to administer the affairs of a city. He asserted that spending the money raised by taxes to the best advantage was essentially an engineering problem and that city officials should be trained engineers. With an engineering organization the working at cross purposes and the waste of materials and labor now so common would be largely eliminated. For example, the laying of pavements would be done scientifically and provision would be made for pipe galleries, or if that were not feasible, care would be taken to have the pipe and sewer systems in good condition before pavements were laid.

LIBRARY

AN INTERESTING JOB ON THE GRIDLEY AUTOMATIC TURRET LATHE

By CHESTER L. LUCAS*

The accompanying halftone and line illustrations show an interesting job done on the Gridley single-spindle automatic turret lathe. The work is a three-inch shrapnel shell which is made on the 3¼-inch machine. The steel from which the shell is made is extremely tough. The specifications are from 125,000 to 135,000 pounds tensile strength, 110,000 pounds elastic limit, a twenty-five per cent reduction of area, and a twelve per cent elongation. It will be seen from the above specifications that the steel is, of necessity, very tough and difficult to work; in addition, a large taper reamer must be used, and the outside of the shell must be relieved throughout the central portion. It is also necessary to machine the piece to extremely accurate dimensions, all of which tends to make the work still more difficult, and, therefore, more interesting.

Fig. 1 shows a view of the shrapnel shell. It is approximately three inches diameter and eight inches long and the limits allowed for the sizes are extremely close throughout, both inside and outside. Fig. 4 shows the successive steps employed in machining the piece complete, the four views presented representing the appearance of the work and the operations performed at each indexing of the turret. Fig. 2 shows the machine complete, and Fig. 3 will enable the operation of the different parts to be more clearly understood.

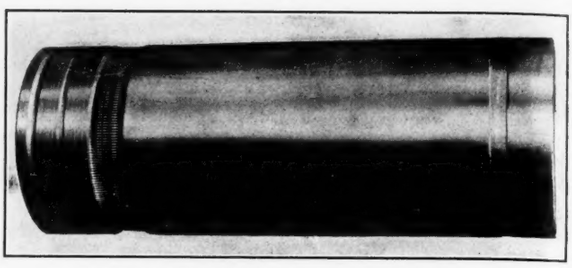

Fig. 1. Three-inch Shrapnel Shell made on a Gridley Automatic Turret Lathe

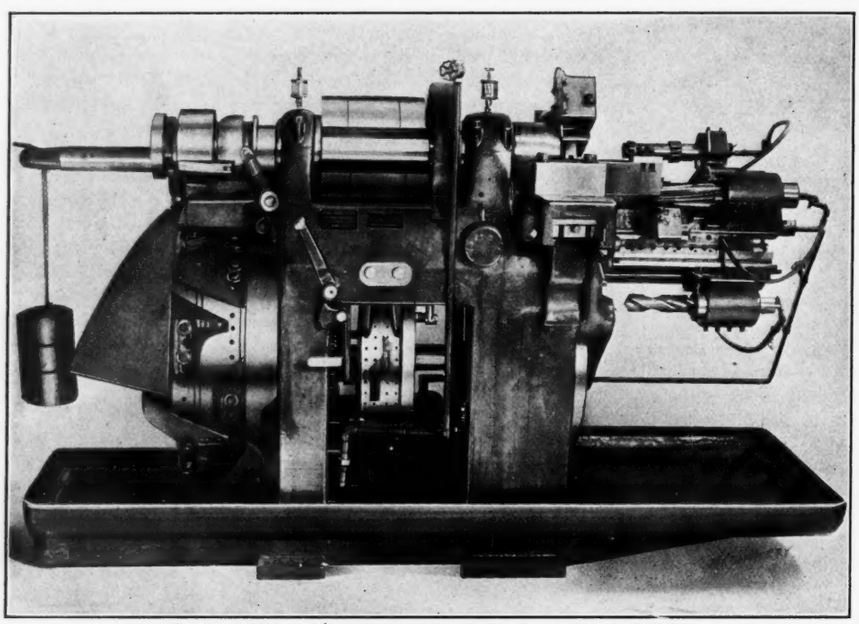

Fig. 2. Gridley 3 1/4-inch Automatic Turret Lathe (Single Spindle)

While the operation of the Gridley automatic turret lathe is generally understood by mechanics, it may be well to state briefly the general principles upon which work is done in the single-spindle machine. In this type of machine, the position of the work does not change as it does in the multiple-spindle machine, but the turning is accomplished by the operation of tools mounted on tool-slides which, in turn, work on a turret that revolves about a horizontal axis, successively presenting the tools for operation upon the work. This will be readily understood by glancing at the illustration Fig. 3. It will also be noticed from this illustration that the forming tools and cutting-off tools are operated from a face-cam at the lower part of the machine. The forming slide is actuated by a cam-groove cut in one side of the cam-plate while the cutting-off slide receives its movement from a cam-groove on the reverse side of this plate.

At the first position of the turret, a large 2 11/32-inch high-speed oil drill is run into the bar to a depth of 6 1/32 inches, and, at the same time, a knee-turner located on the tool-slide turns the outside of the stock, thereby removing the scale from the bar. Referring to Fig. 3, which shows the turret in the third position, the end of this large drill is shown at *A*, and, of course, when at work, it would be in the position of the reamer which is shown at *F*. The time elapsed at the completion of this part of the work is eleven minutes, five seconds.

At the second position of the turret, a smaller drill, 2 1/16 inches diameter, which is shown at *B*, is run in at the bottom of the hole previously drilled, to a depth of 29/32 inch. At the same time a counterboring tool, which is located at *C* and which is attached to the drill with a set-screw, is at work counterboring the end of the hole in the shell. During the time that this drilling and counterboring operation is being performed, the forming tool shown at *D* is being fed into the outside of the head of the shell, finishing the three grooves as shown; in addition a

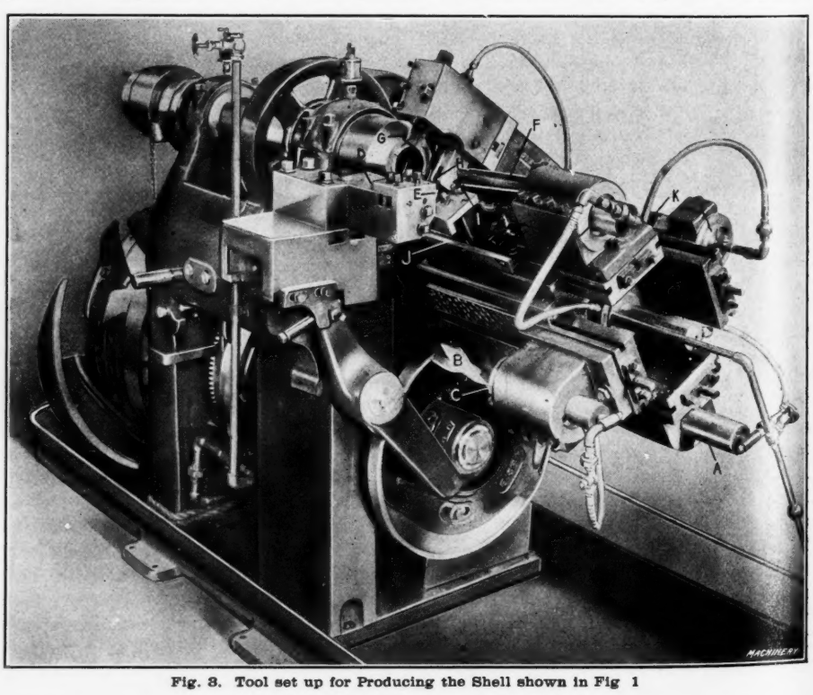

Fig. 3. Tool set up for Producing the Shell shown in Fig 1

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sizing tool *E* which is at a fixed distance from the forming tool, comes in and sizes the work to exactly the right length. The time elapsed up to the finishing of this part of the work is thirteen minutes, thirty-five seconds.

At the third position of the turret, which by the way, is the one shown in Fig. 3, the large taper reamer *F* is run in, which operation removes the bulk of the stock for the taper, and a

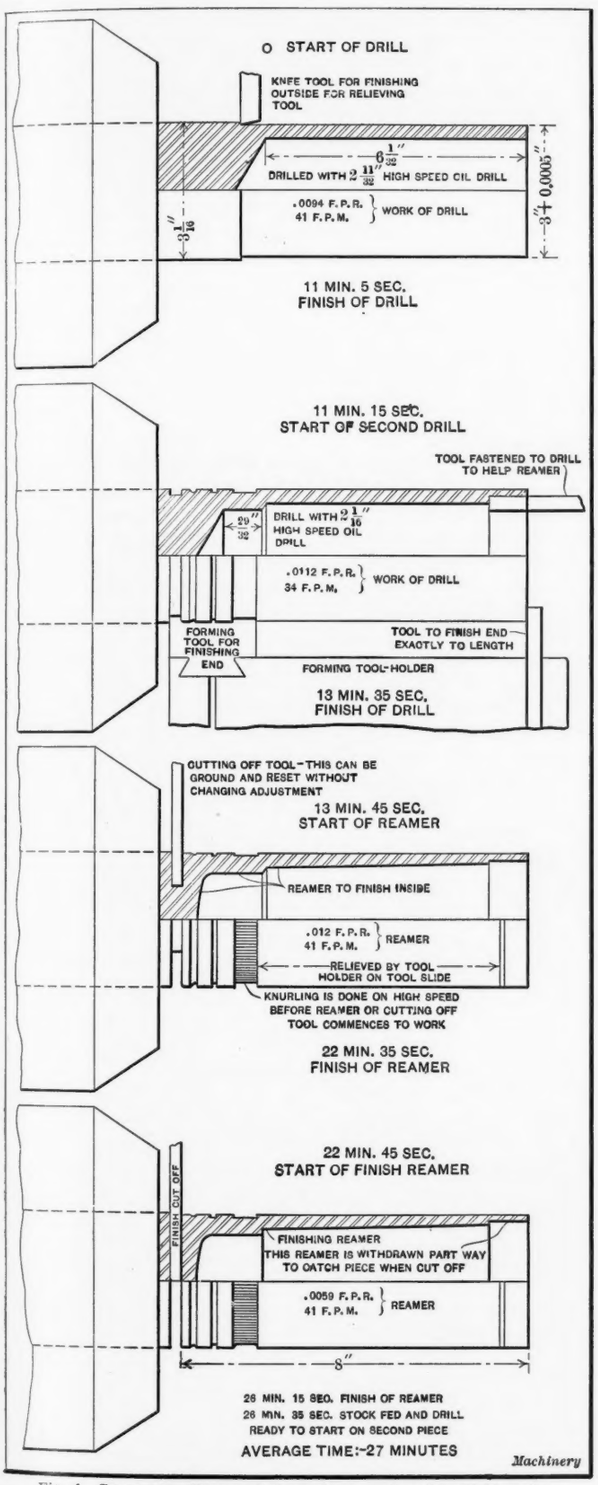
START OF DRILL
KNEE TOOL FOR FINISHING OUTSIDE FOR RELIEVING TOOL
DRILLED WITH 2 11/32" HIGH SPEED OIL DRILL
.0094 F. P. R.
41 F. P. M.
WORK OF DRILL
0.0005"
11 MIN. 5 SEC.
FINISH OF DRILL
11 MIN. 15 SEC.
START OF SECOND DRILL
TOOL FASTENED TO DRILL TO HELP REAMER
DRILL WITH 2 1/16" HIGH SPEED OIL DRILL
.0112 F. P. R.
34 F. P. M.
WORK OF DRILL
FORMING TOOL FOR FINISHING END
TOOL TO FINISH END EXACTLY TO LENGTH
FORMING TOOL-HOLDER
13 MIN. 35 SEC.
FINISH OF DRILL
CUTTING OFF TOOL—THIS CAN BE GROUND AND RESET WITHOUT CHANGING ADJUSTMENT
13 MIN. 45 SEC.
START OF REAMER
REAMER TO FINISH INSIDE
.012 F. P. R.
41 F. P. M.
REAMER
RELIEVED BY TOOL HOLDER ON TOOL SLIDE
KNURLING IS DONE ON HIGH SPEED BEFORE REAMER OR CUTTING OFF TOOL COMMENCES TO WORK
22 MIN. 35 SEC.
FINISH OF REAMER
22 MIN. 45 SEC.
START OF FINISH REAMER
FINISH CUT OFF
FINISHING REAMER
THIS REAMER IS WITHDRAWN PART WAY TO CATCH PIECE WHEN CUT OFF
.0059 F. P. R.
41 F. P. M.
REAMER
8"
26 MIN. 15 SEC. FINISH OF REAMER
26 MIN. 35 SEC. STOCK FED AND DRILL READY TO START ON SECOND PIECE
AVERAGE TIME:-27 MINUTES
Machinery

Fig. 4. Successive Steps and Operations employed in Making the Shell shown in Fig. 1

second step at the end of this reamer finishes the extreme end of the hole at the bottom of the shell. The blades of this reamer are nicked to break the chips as they are being formed. Before the reamer begins to cut, the knurling tool *H* is brought against the work (while it is on the high speed) by the cutting-off slide, which, of course, results in a better knurled section than would result if the knurling of the piece was done at a slower speed. During the reaming operation, the cutting-off tool *G* is run in part way to facilitate the final severing of the piece. In addition, the relieved part of the work is turned by a tool mounted in a tool-holder on the slide of the turret. This tool is shown at *I* and it is operated by a templet *J* which has a raised projection that throws the tool into the work after it has reached the right position with relation to the length of the shell. The total time elapsed up to the finishing of this part of the work, is twenty-two minutes, thirty-five seconds.

At the fourth and last position of the turret, a finishing reamer sizes the outer end of the interior of the shell and is withdrawn but part way, so that when the cutting-off slide comes in and finishes severing the piece, the shell is caught on the reamer and not allowed to drop and possibly be injured by so doing.

The average total time for making this piece complete is twenty-seven minutes. On account of the rigidity of the tool support, the tools do not require sharpening oftener than once for fifty pieces, with the possible exception of the cutting-off tool, which must be sharpened after about half that number of pieces have been done. Considering the toughness of the material, the time in which the piece is made, the accuracy required, and the number of operations performed, this job is an excellent example of lathe work and especially does it represent the possibilities of modern automatic turret lathe practice.

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POWER FROM THE TIDES

In a recent issue of the *Engineering Record*, Mr. J. Royden Peirce discusses the possibilities of obtaining power from the tides. Along the New England coast there still exist a few of the tide mills of early days. They were erected at a time when the cost of power was high, and they continue to operate, defying the most economical modern power plants by their ability to produce power, as one might say, for nothing. Among the most prominent of these tide mills is that at Mamaroneck. It was erected shortly after the Revolution, and although rebuilt a number of times, it has been in almost continuous operation since that time. At present this mill is equipped with two modern mixed-flow turbines and with machinery designed to grind pumice stone. The necessary dam or basin has been formed by joining several islands to each other and to the mainland, thereby enclosing an area of 1,200,000 square feet. Three flood gates automatically allow the water to enter when the sea level is above that of the basin, and they automatically close when the tide begins to recede. The rise and fall of the tide at a certain test was 7 feet, but the basin level dropped only 1.4 feet during the test. Although the area of the basin is nearly 1,200,000 square feet, the average horsepower was found to be only 37. This furthermore was the water horsepower; the actual power delivered by the turbines must have been considerably less.

Along the Atlantic coast in New York and Connecticut there are a number of tide mill ponds. The largest of these is the Holly pond at Stamford, which has an area of approximately 10,000,000 square feet. There is a second at East Bridgeport about one-half as large, and a number of others scattered between Larchmont and South Norwalk. Their combined area is in the neighborhood of 20,000,000 square feet. If these mills averaged 50 horsepower-hours for every million square feet the aggregate output would be about 1000 horsepower. While the best locations have been utilized, there are many bays and indentations along the coast still available, but a study of the hydrographic charts show that the greatest possible power which the North shore of Long Island Sound is ever capable of producing is not more than 5000 horsepower. This is not a very encouraging figure for 100 miles of coast line. It is equal to only one-fifth of the new turbine units in the New York Edison Co.'s Waterside station.

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The man who trades on the ignorance of his fellow-men, or goes on the theory that he knows more than anybody else, and is not going to let anyone into his institution or see what he is doing, generally wakes up some day to find that the world has moved on, and he is only clinging to it by a very precarious tailhold.—*Exchange.*

POWER-DRIVEN AIR COMPRESSORS FOR AUTOMOBILES

The Hartford Machine Screw Co., Hartford, Conn., is manufacturing a very ingenious and compact design of air pump for use on automobiles. This pump is intended for the inflation of tires and can be used in connection with automatic engine starters requiring compressed air. It is built with a single air-compressing cylinder, as illustrated in Fig. 1, or

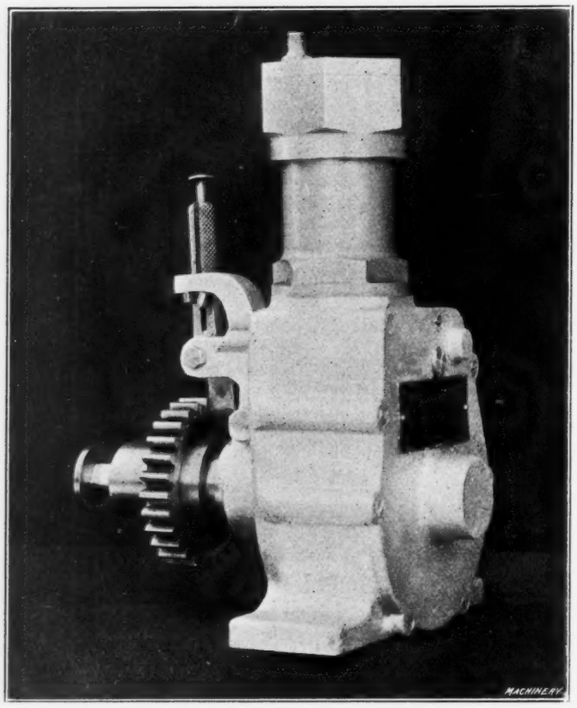

Fig. 1. Compressor for Inflating Tires and supplying Air to Engine Starters

as a combination water pump and air compressor. The interesting feature of this pump, from a mechanical point of view, is the crank mechanism which doubles the stroke of the piston for a given throw of the crank, so that a large capacity is obtained from a comparatively small pump.

The arrangement of the crank is illustrated by the sectional views, Fig. 2. The crank proper is of the center type and has a bearing on each side. The connecting-rod is attached to the yoke *A*, which is mounted on the main crankpin. The opposite end of this yoke is pivoted to link *B*, suspended from the compressor casing. As the crankshaft rotates, this link oscillates to and fro and so controls the movement of yoke *A* that the stroke of the piston is practically doubled. The relative movements of the yoke and crank are clearly shown by the different views which indicate the rotary motion of the crankshaft.

This pump is driven through gearing from the engine and the normal speed is 550 revolutions per minute. At this speed, the pump is said to inflate a 36- by 5-inch tire to a pressure of 85 pounds in less than three minutes without overheating. The piston is made of crucible steel and is hardened and ground. There are no packing rings or packing to cause trouble. Both the intake and exhaust valves are located in the head as shown in the view to the left, Fig. 2. These valves are formed of simple flat disks which close onto raised seats. All bearings are bushed with high-grade bearing metal. The water pump of the combination compressor and pump, is of the rotary type and is intended for circulating water around the cylinder jackets. The air compressor can be engaged or disengaged by operating the small lever seen to the left, Fig. 1, which is provided with an automatic lock to prevent accidental engagement. When the combination pump is used to compress air in a tank for starting the engine, it is equipped with a clutch. Engagement and disengagement of the compressor is then controlled by a pedal under the driver's foot. The casings of these compressors are of aluminum alloy. The single type weighs only 6½ pounds and the combination pump, 16½ pounds.

* * *

INTERNATIONAL SAFETY CONGRESS

The new American idea of the safety engineer, an accident prevention specialist, will be brought to the notice of world industrialists at an International Safety Congress to be held in Milan, Italy, for five days, beginning May 27, 1912. This congress, the first of its kind of international scope ever held, will be for the purpose of setting in motion a world-wide movement for the conservation of human life in industry.

The American Museum of Safety, 29 West 39th St., is making preparations so that the United States will be well represented. An American national committee has been selected by the American Museum to cooperate with the international body and to promote the American ideas and views at the congress. Dr. W. H. Tolman, director of the American Museum of Safety, and other members of the committee will attend the congress.

The following are some of the papers which will be read at the Milan congress:

"The Safety Engineer on a Large Transportation System," by Dr. W. H. Tolman, chairman, American national committee.

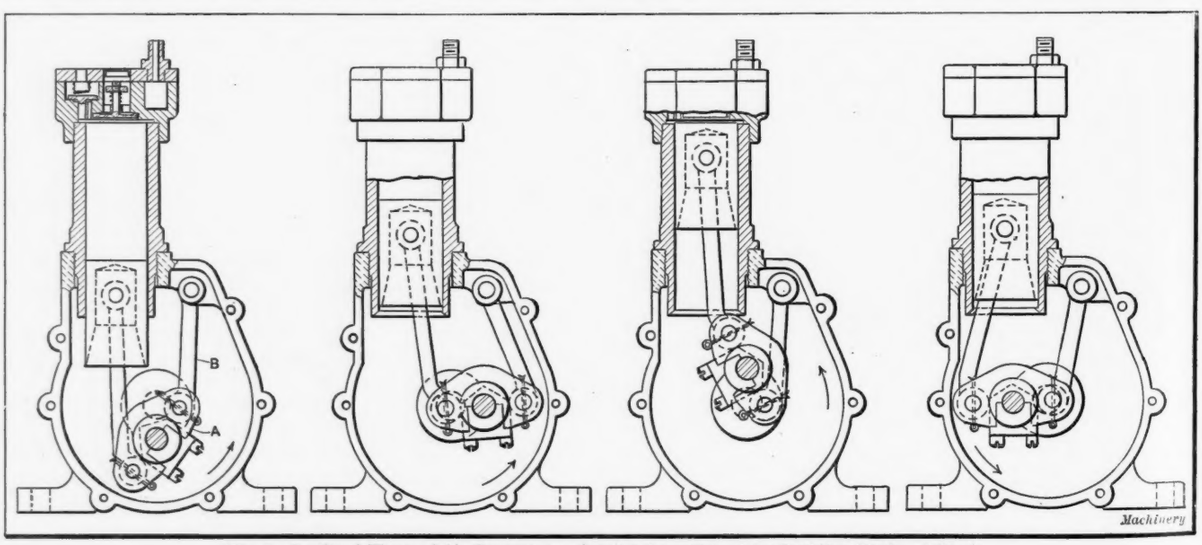

Fig. 2. Sectional Views of Air Compressor, showing Arrangement for Doubling Stroke of Crank

"How the New York Edison Safeguards the Lives and Limbs of Its Employes," by Arthur Williams.

"The Work of the Safety Committee of the United States Steel Corporation."

"Safeguarding the Traveling Public and Protecting the Employes of the Electric Street Railway Association."

"Proper Illumination and Accident Prevention," by J. V. Lansingh, president of the Illuminating Engineering Society.

REPAIRING PLANERS AND SHAPERS*

By EDWARD K. HAMMOND†

The wearing of parts of a machine, through use or misuse, necessarily disturbs its alignment and makes accurate work impossible. In such cases, the wear in each individual member need not be great, because the errors produced are cumulative in their effect, and negligible amounts of error in the different members combine to result in a serious inaccuracy in the work produced by the machine. The average mechanic, experienced in the operation of machinery, is familiar with these facts, but when he attempts to adjust a machine to compensate for wear, he is more than likely to fail. This failure is generally due to the use of improper methods of doing the work.

The firm of A. O. Walworth & Co., 30 S. Clinton St., Chicago, Ill., makes a specialty of rebuilding machinery, and,

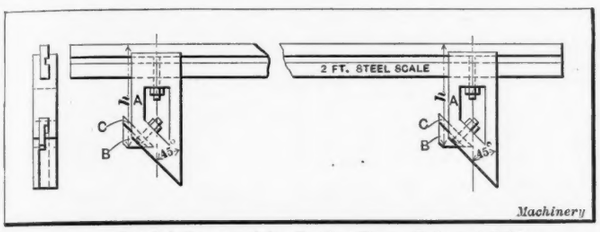

Fig. 1. Special Gage used for Testing Planer Beds and Tables

as the result of a wide experience in this work, special methods have been developed to compensate for the wear in used machine tools. These methods enable a badly worn machine to be adjusted to practically the same degree of accuracy that it possessed when new, and in this article, the practice of this company in the adjustment of planers and shapers will be described. While these methods are all of a special character, they will be readily understood by any mechanic, and their use will make it possible to put machines back into such a condition as to fit them for the production of accurate work.

Method of Adjusting a Worn Planer

In starting upon the adjustment of a planer, the first step is to completely dismantle the machine, in order that the

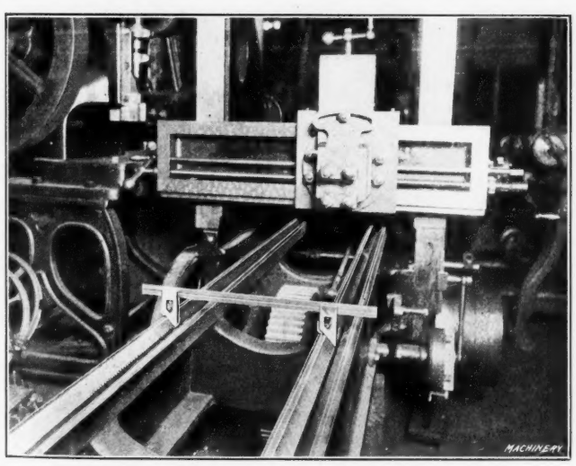

Fig. 2. Testing the Distance between Corresponding Surfaces of the Vees

condition of each part may be determined by tests and inspection. The class of service for which the planer has been used necessarily determines the amount of wear and the points where it will have been produced. In general, however, it may be stated that the table and its bearings in the bed, the crossrail, the saddle bearing on the crossrail, and the shaft bearings, are the points where the most serious inaccuracy is likely to be found.

Planer tables are frequently sprung out of shape as the result of poor judgment on the part of the operators in clamping down the work. When the clamping bolts are tightened to such an extent that the table is drawn out of shape, and the work and table are then allowed to stand in this way for a number of hours, a permanent set is more than likely to be produced. This is especially true if tools or other heavy objects are dropped on the table while it is in this strained condition. In such a case a vibration is set up which causes the metal to readjust itself to the new shape. Where inaccuracy of this kind occurs, it will usually be found that the middle of the table has become high, the amount of the deformation being easily determined with a straightedge. The error in planer tables from this cause is often a very serious matter, an instance having been brought to the writer's attention where an 8-foot planer table was ½ inch higher at the middle than at either end.

In adjusting a table that has been sprung out of shape in this way, it must be remembered that the thickness has originally been properly proportioned to the length and width. Consequently, if any considerable amount of metal is removed by planing, the table will be too thin. This difficulty has been overcome by reversing the process which caused the deformation of the table, in bringing it back into proper alignment. A heavy iron floor-plate is used for this purpose, provided with bolt holes for clamping down the work. The planer table is laid on this plate, face down, and is then clamped tightly against the surface of the plate. After remaining in this position for two or three days, it will be found that most of the inaccuracy has been removed. During the time that

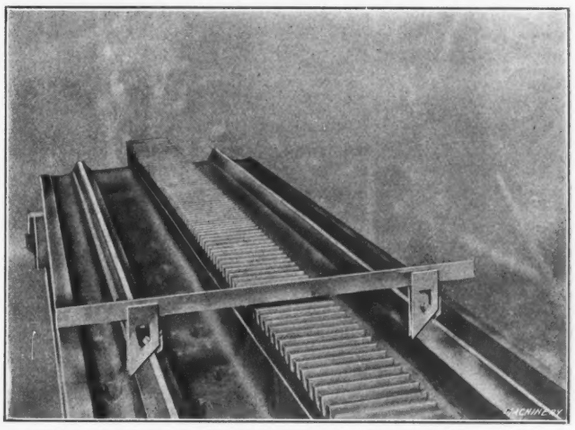

Fig. 3. Testing the Distance between the Planer Table Bearings

the table is clamped to the floor-plate, work can be progressing on other parts of the planer.

Improper methods of oiling often cause serious wear in the vees in the bed and on the table bearings which run in them. Where the bearings have worn quite smooth, there is little chance for proper lubrication, as the oil cannot be held between them. This cause of wear can be easily overcome by taking off the table about once a year, and scraping the vees and bearings. The scraper marks form small pockets which hold the oil and allow it to be distributed over the bearings as required. The bed is tested for inaccuracy of this kind with a straightedge, and if there is found to be any serious amount of wear in the vees, it must be placed on a planer and planed down to approximate accuracy, before scraping to a final finish.

The special gage shown in Fig. 1 is used to maintain the proper distance between the vees during the re-finishing operations. The blade of this gage is a 2-foot steel scale of the kind used on the Brown & Sharpe combination square. The position of the blocks *A*, at either end of the gage, can be adjusted to meet the requirements on different sizes of planer beds and tables; these blocks are secured in any desired position by means of the binding nuts shown. The angle at the bottom is 45 degrees, to fit the standard form of vee. The small triangular plates *B* slide in grooves cut in the inclined edges of the gage blocks, and can be secured in any desired position by means of the binding nuts provided for this purpose. These nuts are carried by bolts which have a slot milled in their sides to fit over the flanges *C* on the plates *B*. In adjusting this gage for use on a given planer bed, blocks *A* are set so that their inclined edges are at the same distance apart as the corresponding sides of the vees, the graduations on the

* See also MACHINERY, July, 1911, "Repairing Lathes and Milling Machines."

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blade of the gage being used for this purpose. The plates *B* are then adjusted with a micrometer caliper so that the distance *h*, from the top of the blade to the bottom of the plates, is the same at each end of the gage. It will be seen in Fig. 2 that plates *B* rest on the top of the bed, the purpose being to steady the gage and bring the blocks *A* into proper alignment with the sides of the vees.

In starting to re-finish the bed, the first step is to plane and scrape the horizontal surfaces at the top of the vees. Accuracy in two directions is necessary; each surface must be finished so that it tests up to a straightedge, and all four surfaces must be in transverse alignment. After each of these surfaces has been accurately finished, their transverse alignment is tested with the dial test indicator, which is mounted

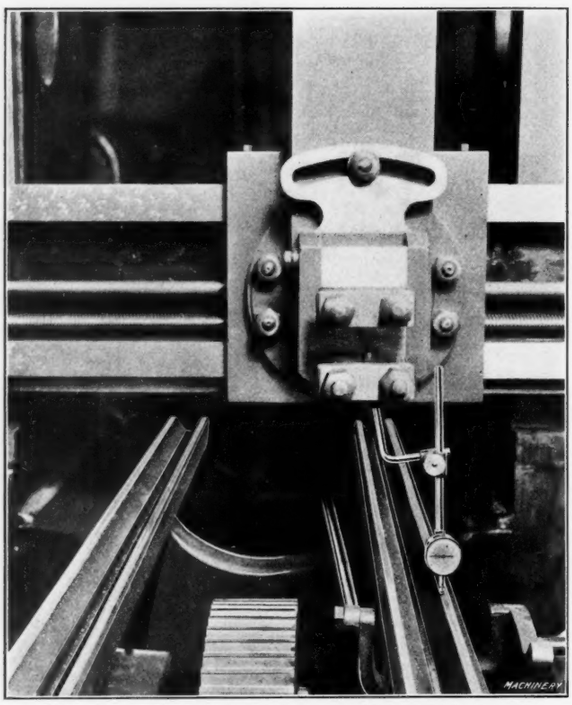


Fig. 4. Method of Aligning the Crossrail with the Planer Bed

in the planer head. The indicator is traversed over each of the four surfaces, and if the proper alignment has been secured, its reading will be the same for each surface; if either surface is found to be too high, however, it must be scraped down until the test gives satisfactory results. The accuracy obtained in this operation is important, because these surfaces of the bed are used in adjusting the housings and to bring the crossrail into proper alignment with the table.

It is only in extreme cases that it is necessary to resort to planing the vees in the bed; the wear at this point is usually so slight that it can be removed by scraping. In performing this operation, the outside surface of one vee is scraped down and tested with a straightedge, and this surface is then used as a standard of reference for the gage in re-finishing the corresponding surface of the other vee. The method of using the gage for this purpose is shown in Fig. 2, the gage being moved along the bed to determine the amount of metal which must be removed at different points. The surface is then scraped down to an accurate finish, as determined with the straightedge, the gage being used at frequent intervals to make sure that too much metal is not removed. The opposite sides of the vees are then re-finishd in exactly the same manner—the surface of one vee is first scraped down to a straightedge and is then used as a standard for the gage in re-finishing the remaining side of the other vee. It is evident that the gage need only be turned end for end to make it available for this operation.

The same general method of procedure is followed in re-finishing the table bearings, the use of the gage providing a method of obtaining exactly the same distance between them as that between the vees; this insures having the table fit properly on the bed. The table is removed from the floor-plate and mounted on the table of a planer, where the bearings are lined up with the dial test indicator to determine the amount of inaccuracy which still exists. If this inaccuracy is great enough to require planing, care must be taken not to remove any more metal than is absolutely necessary. The outside surface of one of the bearings is then scraped and tested with a straightedge, and this surface is then used as the standard of reference for the gage in re-finishing the corresponding surface of the other bearing, as shown in Fig. 3. This latter surface is scraped down to a straightedge, the distance between the bearings being maintained constant with the gage, as previously described for the vees in the bed. The opposite sides of the bearings are then re-finished in exactly the same way.

It is evident that the use of this special gage for both the table bearings and the vees in the bed, assures that they will fit together with absolute accuracy. Far greater precision is attainable in this way than when male and female templets are used on these operations. If any considerable amount of metal has to be removed from the table bearings, it will bring the rack too low to mesh properly with the driving pinion. In such cases, the rack must be removed from the table and have a corresponding amount of metal planed from its bearing.

The crossrail and the bearing of the saddle upon it are subject to uneven wear, owing to the fact that most planer work is done with the head near the center of the rail. To remove the error produced in this way, the crossrail is planed on its face and sides, and then scraped until the re-finished surfaces line up properly when tested by the dial test indicator. The saddle bearing is then scraped to an accurate fit on the re-finished crossrail.

The planer housings are not often subject to any appreciable amount of wear, but their adjustment is sometimes inaccurate, thus throwing the crossrail out of alignment with the table.

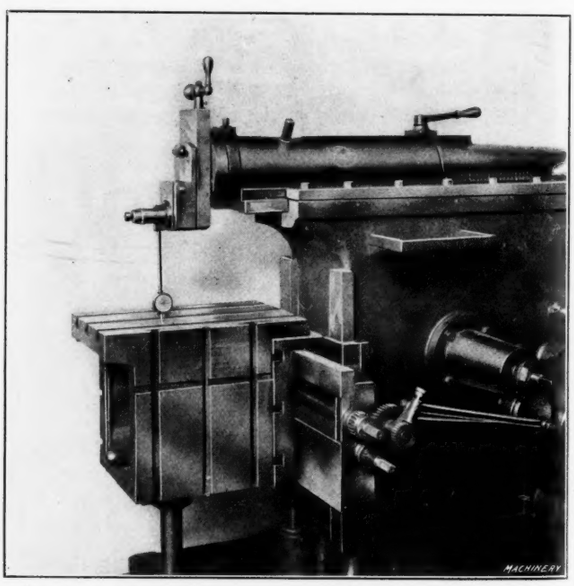


Fig. 5. Proving the Accuracy of a Re-finished Shaper Table

In re-assembling the planer, the re-finished surfaces at the top of the vees in the bed are used as a standard of reference in adjusting the housings, a millwright's steel square being used to bring them into a perpendicular position. After making these adjustments, the bearings of the crossrail are scraped to an accurate fit on the housings; the crossrail is then mounted in position and lined up with the bed. The dial test indicator is used for this purpose, as shown in Fig. 4, the indicator being brought into contact with the surfaces at the top of the vees, first at one side of the bed and then at the other. Corresponding readings of the indicator show the rail to be in proper alignment, but if this test cannot be made with satisfactory results, it is necessary to readjust the housings. The test is then repeated and further adjustments are made on the housings, if necessary, until the proper alignment of the

crossrail has been secured. It is, of course, understood that this alignment of the crossrail with the bed provides for having the table and the crossrail in proper alignment with each other.

Any inaccuracy in the bearings which carry the driving shafts will set up a vibration which manifests itself in an uneven finish on the work. Where such inaccuracy has been caused by wear in the bearings, it must be removed—by scraping, if possible, or by re-bushing the bearings, if they have been too badly worn to be adjusted by scraping.

A small amount of wear on either the rack or driving pinion is not a serious matter, as it does not impair the smooth running properties of the drive. Owing to the greater speed of the pinion, however, it will frequently be worn to a point where the smoothness of the drive is impaired, and in such cases, a new pinion must be provided. Where individual teeth of either the rack or pinion have been damaged, they can be economically repaired by adding metal with an autogenous welding torch and then recutting the teeth. This plan can be followed by sending the work out to a shop which makes a specialty of welding operations, if a torch is not included in the equipment of the plant in which the planer is being rebuilt.

After all of these operations have been completed, the planer is ready to be re-assembled. The machine is then placed in operation to plane down the face of its own table for removing any inaccuracy which exists. The lightest possible cut is taken, and when the operation is completed, the accuracy of the finish is tested by means of the dial test indicator held in the planer head. When these methods are carefully followed, a machine which is so badly worn that it is practically worthless, can be put into condition to produce accurate work.

Method of Adjusting a Worn Shaper

In starting to adjust a shaper for the inaccuracies which have been produced from the wear of its parts, the same general steps are followed that were outlined for a planer. After dismantling the machine, all of the bearings which take part in transmitting power to the ram are examined for wear, and they are either scraped or re-bushed to meet the requirements of individual cases. Where a shaper has been subjected to severe service for a considerable length of time, it will usually be found that the pinion which drives the bull-wheel is badly worn. If this is the case, this pinion must be replaced by a new one.

The ram and its bearings in the frame of the machine are the points where the greatest wear is likely to occur. In compensating for the inaccuracy which is found in these parts, the bearings in the frame are first scraped to a straightedge. The ram is then planed down just enough to remove the wear which has developed, the dial test indicator being used to insure proper alignment of the re-finished surfaces. The ram is then scraped to fit accurately in the bearings in the frame of the shaper.

The crossrail is next mounted on the planer, where it is first planed and then scraped to an accurate finish, as determined by means of the dial test indicator. After this operation has been completed, the saddle bearing is scraped to an accurate fit on the crossrail.

The completion of these operations provides for the smooth operation of the machine. After re-assembling, a light cut is taken over the surface of the table, to provide for having it in proper alignment with the ram, any inaccuracy in the alignment of the crossrail being compensated for in this way. The precision of the finish obtained on the table is proved with the dial test indicator, as shown in Fig. 5; the table is then scraped, if necessary, until an accurate finish has been secured.

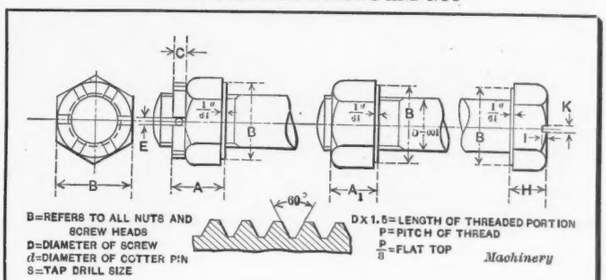
It cannot be too strongly emphasized that the greater part of the wear which develops in machinery is due to improper operating conditions. This is particularly true when machine tools are operated by men who are not trained mechanics, and in such cases, careful inspection should be made at frequent intervals to see that every machine is properly oiled, and that it is not exposed to unnecessary strains. The methods described for proving the accuracy of different planer and shaper parts, can also be used to advantage in detecting wear in the different members of the machines, and when this is discovered before it has assumed serious proportions, it can easily be remedied by a little scraping. Such a course will add greatly to the life of all classes of machinery.

* * *

A. L. A. M. SCREW STANDARD AS REVISED BY THE S. A. E.

The Society of Automobile Engineers has announced the details of the S. A. E. screw standard, which supplants the A. L. A. M. screw standard adopted by the Association of Licensed Automobile Manufacturers in April, 1906. (See MACHINERY's Data Sheet, No. 63, November, 1906.) The revised list is given in the accompanying table. The only changes which have been made are the distances across the flats of ¼-, 7/16-, and 3/4-inch screws and nuts, the changes being from 3/8 to 7/16 inch, from 11/16 to 5/8 inch, and from 1 1/8 to 1 1/16 inch, respectively. The A.L.A.M. screw standard did not go beyond 1 inch in diameter for standard screws, but the S. A. E. standard proceeds by eighths of an inch for screws over 1 inch up to and including 1½ inch in diameter.

S. A. E. STANDARD SCREWS AND NUT



Sizes	Number of Threads Per Inch													
	28	24	24	20	20	18	18	16	16	14	14	12	12	12	12
	Dimensions in Inches														
D	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
A	9/32	21/64	13/32	29/64	9/16	39/64	23/32	49/64	13/16	29/32	1	1 5/32	1 1/4	1 13/32	1 1/2
A_1	7/32	17/64	21/64	9/32	7/16	31/64	35/64	19/32	21/32	49/64	7/8	63/64	1 3/32	1 13/64	1 5/16
B	7/16	1/2	9/16	5/8	3/4	7/8	15/16	1	1 1/16	1 1/4	1 7/16	1 5/8	1 13/16	2	2 3/16
C	3/32	3/32	1/8	1/8	3/16	3/16	1/4	1/4	1/4	1/4	1/4	5/16	5/16	3/8	3/8
E	5/64	5/64	1/8	1/8	1/8	5/32	5/32	5/32	5/32	5/32	5/32	7/32	7/32	1/4	1/4
H	3/16	15/64	9/32	21/64	3/8	27/64	15/32	33/64	9/16	21/32	3/4	27/32	15/16	1 1/32	1 1/8
I	3/32	7/64	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8	7/32	7/32	1/4	1/4
K	1/16	1/16	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	3/32	5/32	5/32	3/16	3/16
d	1/16	1/16	3/32	3/32	3/32	1/8	1/8	1/8	1/8	1/8	1/8	11/64	11/64	13/64	13/64
S	7/32	17/64	21/64	9/32	7/16	1/2	35/64	39/64	43/64	25/32	29/32	1 1/64	1 9/64	1 17/64	1 25/64

The material from which the screws and nuts are made is steel having a tensile strength not less than 100,000 pounds per square inch, and an elastic limit of not less than 60,000 pounds per square inch. The screws as well as the screw-heads are to be left soft, and the plain nuts are to be left soft, but the castle nuts are to be casehardened. It is assumed that when screws are to be used in soft materials, such as cast iron, bronze or aluminum, U. S. standard pitches will be used.

* * *

ERICSSON'S MEMORY HONORED

The American Society of Swedish Engineers celebrated the near fiftieth anniversary of the battle between the *Monitor* and the *Merrimac* in connection with its annual dinner at the society's house in Brooklyn, N. Y., February 17. The celebration commemorated Capt. John Ericsson, the famous Swedish-American engineer who invented and designed the *Monitor*. Mr. Erik Oberg, associate editor of MACHINERY, spoke on "John Ericsson the Man," and W. L. Axel Warn, Albany correspondent of the New York *Times*, briefly described the famous engagement between the two vessels which took place in Hampton Roads, Va., March 9, 1862.

THE MANUFACTURE OF STEEL BALLS

INSPECTING, GAGING AND TESTING

By ROBERT H. GRANT*

In the previous articles on the making of steel balls in the February and March numbers, the making of the blanks, the rough-grinding, the hardening and the finish-grinding of steel balls has been taken up. In the present article it is proposed

Fig. 1. Inspecting the Balls

to treat of the inspection, grading, gaging, and testing of the balls, and also to review the various uses of steel balls, as well as to give some advice to purchasers and users regarding the quality of balls.

The Burnishing and Tumbling Processes

When the balls come from the oil grinders, they have a dull finish and must be burnished or tumbled. The burnishing can be done in the oil grinder with a set of rings having grooves in them the exact size of the balls. A light oil is used, and after a very short run of the machines, a finely polished surface will be produced. This process, however, is expensive, and the ordinary tumbling method is most generally used. The tumbling barrel universally adopted is of is most generally used. The tumbling barrel universally adopted is of the regular iron tilting type. The balls are placed in the barrel in sufficient quantities so that, when they roll over and over, their weight will cause enough friction between them to polish them. A polishing material is placed in the barrel, and the latter is allowed to run at least ten hours to produce a good surface. The balls are then cleaned off by tumbling them in sawdust, and are later placed in another barrel with finely cut kid leather. This final tumbling brings out the high polish.

Inspection

The balls are now ready to be inspected, which is done almost exclusively by girls. The skill and rapidity which can be obtained in doing this work is certainly most remarkable. One girl can inspect fifty thousand ¼-inch balls, picking out seven or eight different grades, in ten hours. This inspection, as indicated in Fig. 1, is done on glass plates which are about ten inches square and inserted in a frame so that the balls cannot roll off. The under side of the glass is painted so as to reflect the light. The plate is about half filled with balls and is placed upon a box which is tilted slightly towards the inspector. This causes the balls to always roll to the front. The inspector holds in her hand a magnet resembling in shape a knitting needle. The end is sufficiently magnetized to raise one ball of the size being inspected from the glass. In the other hand the inspector holds a piece of heavy white paper 4 inches wide by 8 inches long, which sheet slides under the balls. This makes the balls revolve, and with the magnet defective balls are picked out. The defects consist of pits, bands, dents, scale, rough grinding marks, etc.

The different grades are separated in boxes, placed to the right of the inspector, and they are used for different purposes according to the requirements placed on the balls. It is evident that different grades of balls may be used when it is remembered that ball bearings are employed in so many different kinds of devices, such as bicycles, clothes-wringers, hand trucks, sash pulleys, hinges, etc.

After the balls have been inspected for defects they are rolled back and forth on the glass plate in order that those that are out of round may be picked out. As the balls which are not perfectly spherical will take a zigzag motion when rolling down the plate, and the true balls will run straight, it is comparatively easy for the inspector to pick out the imperfect ones. An expert inspector does not stop each time she picks up a ball to place it in the boxes, but will usually toss it into the palm of her hand, which will generally hold all of one grade that she will pick out from the batch of balls on the plate. Balls larger than ¾ inch in diameter are generally taken up by hand and looked over. Those that are out of round in the larger sizes are taken out while measuring the balls.

Grades of Balls

Balls are generally graded into four main classes, known as alloy, and A, B, and C grades. The steel for the alloy balls contains chromium, and these balls have the greatest crushing strength. They must be absolutely free from defects as regards material and finish, and must not vary in size more than 0.0001 inch. Balls classified as A-grade are made from high-grade tool steels, accurately finished, and thoroughly inspected, and must not vary over 0.001 inch above or below the exact dimension. The balls known as B-grade are the seconds taken from the two higher grades mentioned. These are the balls which show slight, almost invisible, defects, and which vary from 0.001 to 0.002 inch. The C-grade, commonly known as hardware balls, are those picked from the higher

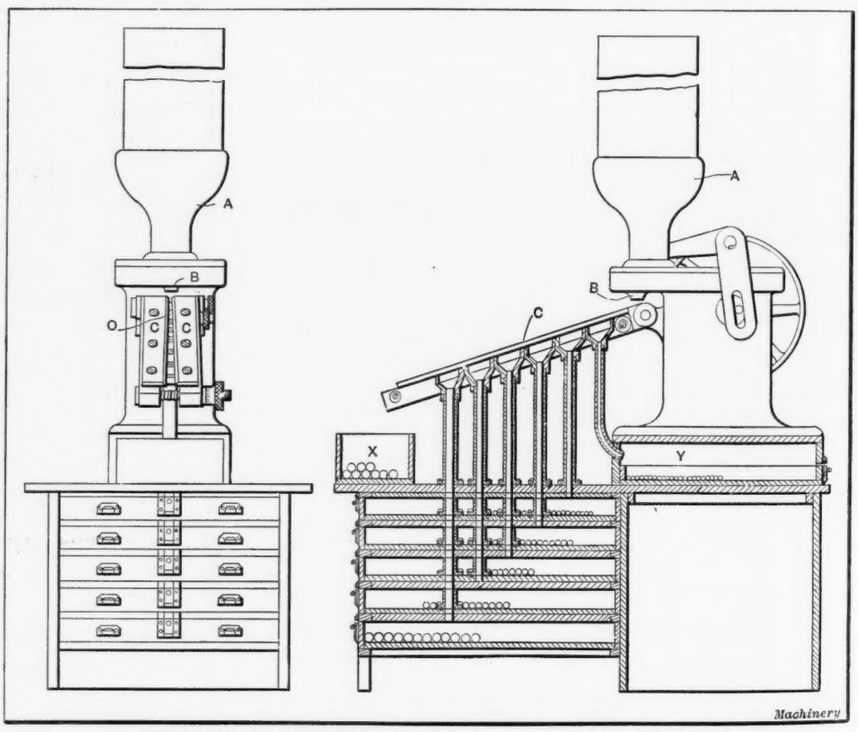


Fig. 2. The Grant Ball Measuring Machine—U. S. Patent No. 583,456

* Address: 912 Oakland Ave., Ann Arbor, Mich.

grades when these show a defective surface. Whether these balls are gaged or not depends upon the use to which they are to be put.

The Gaging of the Balls

After the inspection, the balls are automatically gaged, the gaging being done in a gaging machine in which the balls are fed from a hopper and allowed to roll down between two hardened straightedges and to fall into tubes which carry them to the proper drawer, as indicated in Fig. 2. This illustration shows the Grant ball measuring machine. At *A* is shown the automatic dropping machine, and at *B* the delivery spout through which the balls drop into the measuring slides *C*, provided with a longitudinal slot or opening *O* between them. The sides of the slot may be accurately separated any

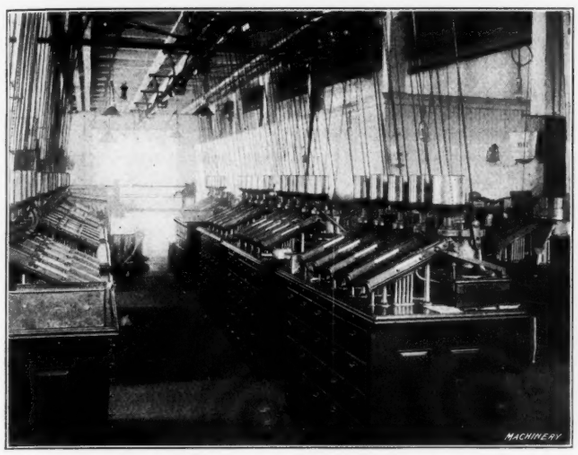


Fig. 3. A Battery of Grant Gaging Machines

desired amount by the micrometer adjusting screws provided at both ends. Consequently, the flare of the slot may be adjusted so that it is possible to determine exactly what the diameter is of the balls that will drop into each of the tubes and drawers beneath the measuring slide as the balls roll down along it.

As is clearly shown in the illustration, pockets are arranged successively beneath the inclined slot, and are connected by pipes with the drawers of the cabinet underneath. It is evident that in this way balls of the same size will go into the same drawer each time, the balls that go into the middle drawer being those of correct size, those that go into the upper drawers being those that are too small, while the large balls will go into the lower drawers. The balls that are entirely too large will run down the full length of the measuring slide and will be deposited in the box *X*. Those that are deposited in the drawers of the cabinet will be from 0.0025 to 0.005 inch too large or too small, according to the setting of the slides.

The exact arrangement of these measuring devices varies somewhat. In Fig. 3 is shown a group of the type of machines just described. A rack is run through the center of the machine. In this rack, directly under the hopper, there is a hole having a bushing in it of the size of the ball to be gaged. The ball drops from the hopper into this bushing and is carried forward until it comes to an opening which is connected with a tube for carrying the ball to the measuring slides. The rack is operated by a sector of a gear mounted on a shaft having an eccentric pin on one end and a pulley on the other. Inside of the hopper there is a small tube which is operated up and down by two levers, one being attached to the eccentric pin and the other to the tube. This arrangement prevents the balls from clogging so that the bushing in the rack is always ready with a ball to carry forward, thereby constantly feeding balls to the measuring slides.

In Fig. 4 is shown the writer's machine with the measuring slides removed. This particular machine is worked by a worm and worm-wheel instead of by a rack. There are two disks, beneath the balls in the hopper, the upper one of which is keyed to the shaft fastened to the worm-wheel and hence revolves. This disk has a series of holes drilled near the periphery, these holes being 0.005 inch larger than the ball to be gaged. The lower plate has a hole in it directly above the measuring slide, so that when the upper disk carrying the balls presents a hole directly above the hole in the lower disk, the ball will drop through the hole and tube onto the measuring slide. As the hopper is full of balls there is a liability of clogging, because two balls may have a tendency to drop through the hole at once when the opening is presented. The clogging tendency is overcome by a cut-off made of a thin piece of tool steel with beveled edges, which covers two holes in the revolving disk, the holes covered being the one directly over the lower disk and the one next to follow. This prevents jamming of the balls. The remainder of the machine and cabinet is substantially the same as the machine shown in Fig. 2.

In the Putnam gaging machine the hopper is worked practically the same as in a machine for slotting screws. Fingers raise the ball, allowing it to fall into a trough, and then through a tube onto the measuring slides.

This mechanical gaging and sorting of balls is applied to all sizes up to and including ⅝ inch. The large sizes are measured by hand by micrometers. The girls employed for this work pick them up one by one and measure each ball separately over several diameters, throwing them into small boxes placed before them, each of the boxes containing a certain size of balls between the limits of measurements adopted. This work is very rapidly done, as the operators become very skillful.

Counting the Balls

The next operation is the counting and boxing of the balls which at first sight might be assumed to be a tedious and very slow operation. So it would be were it not for the mechanical means adopted for doing this work. Balls up to ⅜ inch in diameter are counted by means of a counting board, as indicated in Fig. 5, which has holes sunk in it 0.010 inch larger than the ball. Around the board is tacked a narrow strip of wood to prevent the balls from rolling off.

Fig. 4. A Modified Type of Grant Measuring Machine, with Gaging Slides removed

The balls are then poured upon the board and all balls which do not find a hole to enter are allowed to run off. As there is an exact known number of holes in the board, the counter immediately knows how many balls she has, and she transfers them immediately from the counting board into a pasteboard box in which the balls are packed. In this way one girl can easily count a million balls a day and do other work besides.

The pasteboard boxes are made of a telescoping form and lined with paper which is free from acid and which has previously been soaked in an anti-rust compound. The balls, which have a very high polish, would otherwise easily rust on account of sweating, which is caused by the difference in temperature of extreme heat and cold. It is very essential that steel balls should be kept in a room properly heated.

The Testing of Balls

The testing of a steel ball for crushing strength should be done between hardened plates by placing three balls in a

tube into which they nearly fit. The center ball is the one that will be tested. The upper and lower balls will, of course, sink into the plates, and this will give them more of a surface bearing than the middle ball, which bears only in two points upon the upper and lower balls; hence the middle ball will ordinarily give way first. As the pressure is applied, a double pressure cone will be formed inside of the ball, this cone having its apexes where the outside balls bear on the middle ball. If properly hardened, a ball will break into several pieces. This method is the proper way to test a ball, but there seldom are two balls that will stand exactly the same load when tested. This is caused largely by the methods in which the ball blank is made. As will be remembered from the description of the making of the blanks in the February number of MACHINERY, the balls in the forging process are much more dense at what might be called the "poles," that is, where they join the next ball forged, than at the "equator." Therefore, if the center ball being tested has the point of contact on the "equator," it will not stand within ten or twenty per cent of the load that it would stand if the points of contact were at the "poles." The same method of reasoning may be applied to stamped and turned balls.

Through the means of this testing operation and the appearance of the fracture, it can be determined whether the balls have been properly hardened. Every batch of steel, no matter how carefully made, usually requires a slightly different

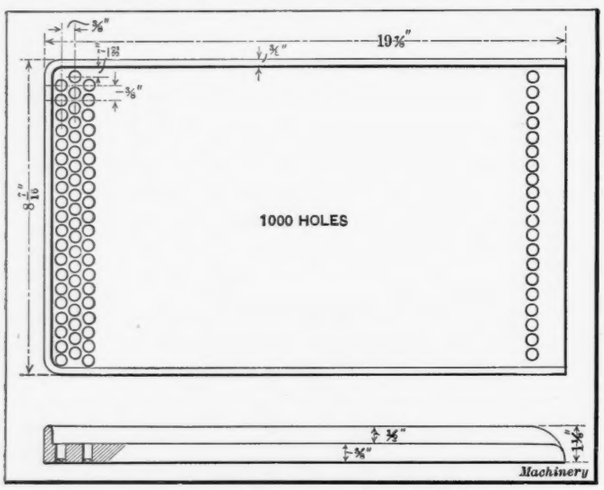


Fig. 5. Counting Board for 5/16-inch Balls

treatment in hardening, and what this treatment is must be determined by the man responsible for the hardening work. The accompanying table shows the crushing load ordinarily required by ball manufacturers for regular tool-steel balls.

Size of Ball in Inches	Ultimate Strength of Ball in Pounds	Size of Ball in Inches	Ultimate Strength of Ball in Pounds
1/16	390	5/8	39,000
3/32	875	3/4	56,250
7/64	1,562	13/16	66,000
1/8	2,450	7/8	76,000
3/16	3,496	15/16	88,000
7/32	4,780	1	100,000
1/4	6,215	1 1/8	125,000
5/16	9,940	1 1/4	156,000
3/8	14,000	1 1/2	225,000
7/16	19,100	1 5/8	263,000
1/2	25,000	1 3/4	306,000
9/16	31,500	2	400,000

The figures above have been adopted after a great many years of testing and are considered by the manufacturers safe figures with which to calculate. Of course, in selecting a ball for a bearing, a factor of safety of ten should always be adopted unless the bearing is used in an extremely narrow space. The grooves in which the balls run when heavy loads are imposed should be round instead of V-form. No figures can be given relating to tests of balls made from alloy steel, because these steels give such irregular results that the manufacturers have been unable to compile any data that would be in any way satisfactory. It is, however, safe to state that the alloy-steel balls will stand from 25 to 50 per cent more than the regular tool-steel balls.

Balls of Other Materials than Steel

Balls are made of a great many other materials, brass and bronze, for instance, being used extensively for oil-well devices where acid is found in the crude oil. Such balls are also used in valves where the material to be pumped will rust steel balls and cause corrosion, and also in electrical work. German silver balls are used in Yale locks to prevent corrosion when used on shipboard or in other places where they would be subjected to the damp sea air. Casehardened machine steel balls are used extensively in agricultural implements and similar apparatus on account of being inexpensive. Chilled cast-iron balls are used in turntables, trucks, and for similar requirements.

The Uses of Steel Balls

It may be said without exaggeration that balls are used in nearly every kind of article that it is possible to name provided it revolves. They are used in the cheapest kind of hardware and in the finest mechanisms and surveyors' instruments. Balls 1/16 inch in diameter are used in electric meters and typewriters. The number of balls being used for these purposes alone is from fifty to seventy-five millions per year. German silver balls 3/32 inch in diameter are used under the tumblers of a Yale lock to prevent the tumblers from becoming worn by the constant sliding of the key into the lock. Steel balls 1/8 inch in diameter are most extensively used in bicycle pedals. Some people think that the bicycle industry is no longer of the importance that it once was. This is a mistake. More bicycles are made at the present time than ever before, and about fifty million steel balls are used yearly in the pedals alone.

Sewing machines are now being provided with ball bearings. Millions of 3/16-inch balls are used for this purpose yearly. Some fifty million 1/4-inch balls are used every year in clothes-wringers; 1/4- and 5/16-inch balls are used exclusively for bicycle bearings, and the quantity used runs into hundreds of millions per year. Balls of the same size are used in thrust bearings in motor boats. Balls from 3/8-inch to 3/4-inch diameter are used extensively in automobiles. The quantity of balls so used is estimated at not less than five hundred millions a year. Larger balls of, say, 1 1/8 inch in diameter are used in oil-well pumps, road rollers and traction engines. The quantity being used for these purposes is not less than five hundred thousand a year. One of the most important uses for 1 1/4-inch balls is that in the side bearings on trucks for steam and electric cars. Still larger balls are used for a great many other purposes, including waterwheels, step bearings, locomotive cranes, drawbridges, etc.

Balls are made up to six inches in diameter, and some are used in very peculiar places. Balls of from 4 to 6 inches in diameter are now used by a Canadian concern in a whistling buoy. This buoy has a large tube in which the ball is placed, evenly balanced on the top. The end of the tube has a whistle. The ball, as the tube dips on account of the waves, rolls to the lower end, compressing the air by its weight, and thus blows the whistle. Then it rolls to the opposite end and causes the whistle to blow again.

As already mentioned, brass and bronze balls are used extensively in valves, electrical meters, and bearings where dampness or acid is liable to come in contact with the balls. The number of balls made from these materials is not less than fifty millions per year.

Points for the User and Purchaser of Steel Balls

In the following the essential points relating to the manufacture of balls which should be kept in mind by a purchasing agent or consumer are given. Nothing but a tool-steel ball should be used for high-grade work, and it is very important that it be properly heat-treated. Do not be deceived by a finely polished ball, as high polish and deep scratches (which show only under a magnifying glass) do not necessarily indicate a good ball. In fact, the outside appearance has little or nothing to do with the wear of a ball, for a dull looking ball may be just as good as one with the highest polish. The polish is merely the result of the tumbling process.

The first requirement is that the right material has gone into the balls. It costs but little to have the steel analyzed so that the purchaser may know whether he is getting a tool-

steel ball or a machine-steel ball. The fact that the ball has only a point bearing makes it the more important that it be made from good material in order to stand the pressure to which it may be subjected. Casehardened machine-steel balls ought not to be used when heavy duty is required. Naturally there is some difference in the quality of the steel that costs thirty-five dollars per ton from that which costs one-hundred-fifty dollars per ton.

It is true that a ball can be casehardened very deeply, in fact, almost through to the center, but it should be remembered that casehardening implies adding carbon to the steel under a high heat, which causes the pores in the steel to open so that the carbon can enter. The process, however, does not remove the injurious elements, such as phosphorus, sulphur and silicon, of which the cheaper steel contains a large percentage. It is, of course, perfectly satisfactory to use casehardened balls for many purposes, but when it comes to a really high-grade article, the highest class of steel is to be preferred.

In order to determine whether a ball has been properly heat-treated, place the finished ball in a piece of waste on an anvil and break it open with a heavy blow. The waste prevents the pieces from flying around. If the ball is properly heat-treated, the break will show a soft silky-appearing surface—the grain of the steel being fine. If it has not been heat-treated, it will look coarse and granular, having more the appearance of cast iron. As a further illustration of why the ball should be heat-treated, the following tests made by the writer when with the New Departure Mfg. Co., may be of interest. The balls tested were made of tool steel; they were ¼ inch in diameter and drawn to 420 degrees F.

Ground; not Annealed before Hardening	Headed and not Ground; Annealed before Hardening
4800	7500
5700	8150
6300	8200
6150	7200
5800	6880
5600	7300

It will be found that the average crushing load of the balls that were not annealed before hardening is 5725 pounds, while the average crushing load of the balls that had been annealed before hardening is 7538 pounds; hence the heat-treated ball is some 1800 pounds or nearly 30 per cent stronger than the balls which were not heat-treated. The heat-treatment not only strengthens the balls, but prevents them from flaking off, crumbling, etc. It distributes the molecules so that the steel is at rest.

If during the test the ball should break in half, it would indicate that it had not been properly drawn after hardening, but was still subjected to internal stresses. If such a ball is placed in a bearing, it would easily break if subjected to a severe shock or strain. If a ball has been properly drawn it can be touched with a fine Swiss file, and under the blows of a heavy hammer it will dent slightly and break into several pieces.

Balls over 5/16 inch in diameter that have been turned or headed should not be used for heavy duty, as they are not as good as balls for which the blanks have been forged. The headed ball, on account of the severe shock to which the metal is subjected when cold, cannot be treated so as to stand the strain that the forged ball will stand. A turned ball is cut from a rod which is rolled, so that the grain of the steel is in a lengthwise direction; hence when a ball is turned from this bar the surface of the ball consists of a mass of exposed fibers. When put under a heavy strain, as in a thrust bearing, it will pit and flake off. The surface of the ball should be smooth, that is, all the marks from the rough-grinding process should have been removed in the finish-grinding. If this has been done it can be readily determined by a magnifying glass.

A ball made from a forged blank cannot be hardened properly unless the decarbonized surface has been wholly removed. Some manufacturers attempt to keep the forgings as small as possible in order to save material and time in grinding, and in many cases it is then impossible to remove all of the decarbonized surface. Hence when the ball is hardened, rough marks and soft spots can be detected. The soft spots are much brighter than the properly hardened surface.

If balls are to be used for special purposes, this should be designated in the order sent to the ball manufacturer. In order to be able to supply a ball that will give satisfaction, it is necessary that he be furnished with information as to what the ball is to be used for, the speed and load at which it will be used, and the kind of bearing employed. Then the balls can be drawn to a degree of temper adapted to the particular purpose in view, and thus satisfaction can be guaranteed to the purchaser. It is also very important to see that the balls that are furnished are not out of round, as this would cause the bearings to "catch" and "jump." The resulting bearing will run unsatisfactorily, and will rattle on account of the fact that the balls are loose at one point and tight at another. The actual size of the ball does not make a great deal of difference, provided the balls are all of the same size. In other words, in a lot of one-hundred-thousand balls, if they are found to be 0.0005 or 0.001 inch under size they will give satisfaction if they are all used before the next shipment can get mixed up with them.

It has already been mentioned that the temperature of the room in which the balls are stored must not be too low. The temperature of the stock-room should be kept the same at all times, and on Sundays and holidays, when the factory is closed, it should be especially heated, for a ball which becomes very cold and then is brought back to a warm temperature will soon begin to rust and cause a great deal of trouble.

Summary of Ball-making Processes

In order to fix in the reader's mind the various processes that a ball passes through, from the time that the blank is produced from the rough stock until the finished ball enters the stock-room, a general summary of the processes described in the three articles comprising the present treatise on the manufacture of steel balls will be given.

There are several methods for producing the ball blank. One is that of turning the ball blanks in a special automatic machine. This method is rapid and makes it possible to produce a blank which requires less grinding than the blanks produced by other methods, but on account of the fact that the fibers of the stock from which the blank is turned are cut and exposed at the surface, a ball so made is of inferior strength after hardening as compared with balls the blanks of which are made by other methods.

Another method commonly used for producing ball blanks is to form the blank in a heading machine. A bar is fed into the machine and pieces of the required length are cut off and headed between dies to a ball shape. This is a very rapid method, and balls up to, say, 5/16 or 3/8 inch in diameter can be made advantageously by this process. As there is no waste, this process for smaller sizes of balls must be deemed the best as well as the cheapest of the methods used at the present time.

The best method of making ball blanks from 3/8 inch to 2 inches in diameter is known as string forging. This method is very extensively used and the balls so produced, when properly heat-treated, are strong and tough in their structure. The balls which have been produced by the heading or forging process must have the fin or flash ground off before they pass to the grinding machines. The process by means of which the fin is removed is called "flashing," and the machine in which it is done is ordinarily termed a "rotary" file. Large balls are flashed separately in a special fixture by an ordinary emery wheel.

The balls are now ready for the dry-grinding process, the grinding being done by an emery wheel acting upon the balls which are held and rotated by suitable means. After being dry-ground, the balls are annealed and then hardened, the smaller balls being quenched in cotton-seed oil, while the larger ones are immersed in brine. After hardening, the balls are washed in boiling soda and then tempered in oil.

After the tempering the balls are ready to return to the finish dry-grinding department, and are finish dry-ground in machines of the kind that performed the rough dry-grinding, but a finer grade of emery wheel is used. From the finishing dry-grinders the balls pass to the oil grinders, where the final grinding operation is performed and where the balls

are brought to exact size. The oil grinding operation is practically a lapping process, no grinding wheel being used. The machine has merely two plates, one of which is grooved, between which the balls roll. The grinding medium is fine emery and oil.

When the balls have been brought to size in the oil grinders, they are given their final finish either by burnishing them in machines similar to the oil grinders, or by being tumbled in a tumbling barrel with a polishing medium. Next they are tumbled in sawdust, and finally in a barrel with cut-up kid leather to obtain the high polish. The balls are then inspected, graded and gaged. The smaller balls are gaged in gaging machines, while the larger are measured by micrometers. Next the balls are ground and packed into boxes and sent to the store-room, which finishes the operations.

* * *

DOURTE VALVELESS PUMP

The pump which is illustrated in Fig. 1 has no suction or discharge valves and is designed especially to handle very trashy matter. Weeds, pieces of rope and other foreign material which may be drawn into the pump are sheared off by the edges of the ports which are located in the piston. This type is being used to pump trashy water out of irrigation ditches and to handle slimes in reduction works. It is also planned to use this pump for handling syrup and heavy oils. The sectional view, Fig. 2, of one of the cylinders of a horizontal type, shows the general arrangement of the piston and ports. A miter gear keyed on the end of the crankpin meshes with the mating gear keyed to the end of the connecting-rod, and the latter is attached to the piston by means of a universal coupling. This mechanism imparts a constant rotary movement to the piston in addition to the reciprocating action. The piston is of the trunk type with an opening at both ends and a partition in the middle. The head end at the left of the partition has a port, as the illustration shows, which alternately registers with the suction and delivery ports. When the piston is in the position shown, both ports are closed, but as soon as the pump rotates in the direction indicated by the arrow, the suction port begins to open. When the crank has moved 90 degrees and is on the "top quarter," the piston port will be exactly over the suction port, and when the opposite "dead center" is reached, both ports will again be closed. When the crank is on the bottom quarter, the piston port will be exactly under the delivery port. It will thus be seen that the piston by its rotary movement regulates the suction and discharge openings. If the pump is reversed or one miter gear is turned through 180 degrees, the pump will operate from the delivery to the suction side or, in other words, the flow will be reversed. The delivery port is formed in a separate saddle which rides on the piston and is held down by adjustable spiral springs, as shown. The suction port is cut out of the solid cylinder. This pump is made at Longmont, Col., and was designed by George L. Sullivan, Bozeman, Mont.

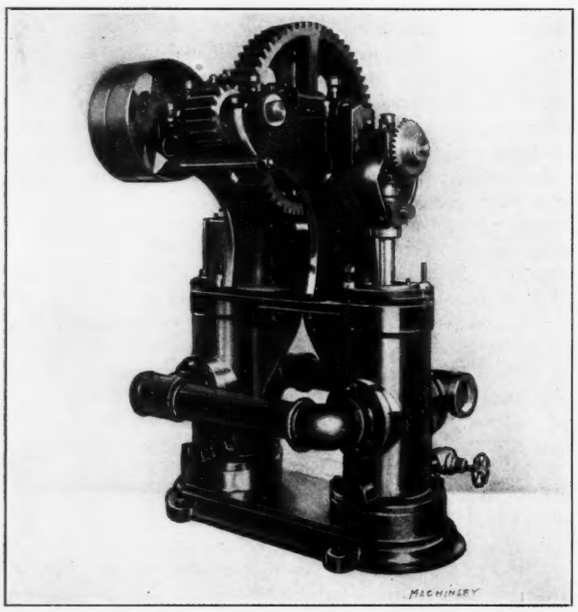


Fig. 1. Duplex Pump without Suction or Discharge Valves

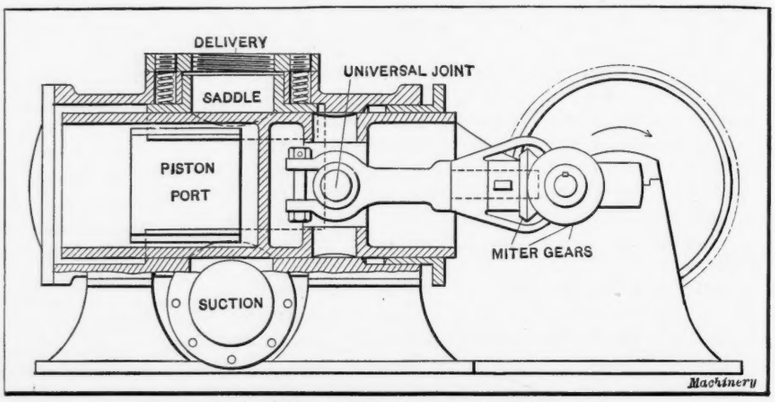


Fig. 2. Sectional View of Valveless Pump of Horizontal Type

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ENERGY THE MOVING FORCE

Many business concerns that have been organized with ample capital and to outward appearance well equipped to succeed, in the course of a few years have gone into the hands of receivers. Other concerns have started with very small capital, under adverse conditions and have prospered. What was the difference in the organization of these typical concerns which meant success for one and failure for the other? Largely brains and energy.

An incident from the career of a well-known machine tool manufacturer in the Middle West is an illustration of the point. Thirty years ago this manufacturer started in business with a small capital, and his hostages to fortune were "a wife and two kiddies on the hill." His money was soon tied up in the business, and no immediate cash returns were in sight. In the emergency he solicited some job work from a large concern and was "turned down," but being insistent and forceful finally secured an order for two hundred flask-pins at ten cents each. They had to be tapered at one end, turned down, shouldered and threaded at the other end, and provided with a hexagon nut. This was before the days of automatics, and after the order was taken the job hunter realized that he was in for a loss if he followed the regular method of production, so he set his brain to work. He went to a dealer in bar iron, got two hundred pieces cut off while he waited, took them in a box on his shoulder to his shop and then rigged up an engine lathe for the job. A boy hired at fifty cents a day, who had never worked in a shop, with the aid of simple tools and the expert assistance of the boss, turned out the job complete in a day at a cost of $2 for stock, 50 cents for nuts and 50 cents for labor, making the total cost $3, not including a small overhead expense.

The brains and energy used in this case were characteristic of the man and the concern he organized. Starting out in this small way it showed $7000 in assets at the end of the first year, and $32,000 the second year, increasing until the investment now represents over a million dollars, and its product is known and used all over the world.

* * *

A user of high-speed drills complained to the maker that he could not get results. The production was not much higher than with carbon steel drills, and much time was lost in grinding. Examination showed that the cutting speed was high, but the feed very fine. The speed was reduced and the feed doubled, the result being that the output of drilled holes was doubled and the squealing and heating of the drills disappeared entirely.

VARIATION IN MACHINE TOOL POWERS

By T. BARTON*

The wide divergence in the power put into machine tools by different makers is a fact not often commented upon, but a walk through any average shop will reveal many instances of it. The writer recently noticed an 18-inch turret lathe on chuck work, with a single-pulley drive, having a pulley 12 inches in diameter for a 5-inch belt, running at 200 R.P.M. Close by was a 2-inch bar lathe, having exactly the same size pulley, but running at 500 R.P.M. It will be seen at a glance that the bar lathe has two and one-half times the power of the turret lathe. Is not this somewhat of an anomaly? The bar lathe operates on work of small diameter, has only one tool cutting at a time, and that tool has a very keen cutting edge. The turret lathe handles work of large diameter, has frequently several tools in action simultaneously, and the cutting edge of the tools is not as keen. Either one machine is under-powered, or the other has a surplus of power which it can never hope to convert into useful work. Both these machines are of standard make, are good sellers, and do good work.

If the power of a machine is in reasonable proportion to the work to be done, then if anything goes wrong, the belt will slip or be thrown off, but if it is very much over-powered, this safeguard is lost. If a machine has twice the power that it needs, it means that, as the driving gears have to be strong enough for the belt, they must be made twice the width otherwise required. This increases the distance between the bearings, and consequently the diameter of the shafts must be increased to retain stiffness. In short, the whole machine must be made larger and heavier, and the belt up-keep cost is increased. The contrast between these two machines led the writer to investigate more thoroughly. Some of the results of this investigation are given in the following: A 3½-inch bar lathe was driven by a 10 H. P. motor; a 3-inch bar lathe was satisfied with a 3 H.P. motor. A 2-inch bar lathe had an 8 H.P. motor; another make of 2-inch bar lathe was content with a 2½ H.P. motor. It will be seen that here is a difference of over 3 to 1 on two machines made for doing identically the same size and class of work.

The increase in belt speed, and use of wider belts, which a geared drive allows, permits a great increase of power, compared with the old cone pulley drives, and in some cases it would appear to be the practice, when cone-driven machines are converted into single pulley drives, to put on a pulley as large in diameter, and as wide as the machine will stand, and run it at the highest permissible speed, without comparing the power thus obtained with that given by the old cone drive, which has probably stood up well to its work.

Below are given particulars of a few single-pulley machines. The first three figures have been multiplied together, giving a result which facilitates comparison:

	Diam. of Pulley, *A*	Width of Belt, *B*	R.P.M., *C*	*A*×*B*×*C*
2-inch Bar lathe	12	5	500	30,000
18-inch Turret lathe	12	5	200	12,000
3-inch Bar lathe	10	3	800	24,000
3½-inch Bar lathe	14	5½	500	38,500
3½-inch Bar lathe	10½	4½	300	14,175
18-inch High speed lathe	13	4½	300	17,550
21-inch High speed lathe	16	5	300	24,000
22-inch Combination turret lathe	10	4½	450	20,250
30-inch Boring and turning mill	12	3½	400	16,800
4-foot Boring and turning mill	12	4	575	27,600
4-foot 6-inch Boring and turning mill	13	5	400	26,000

* Address: 22 Augustus Rd., Coventry, England.

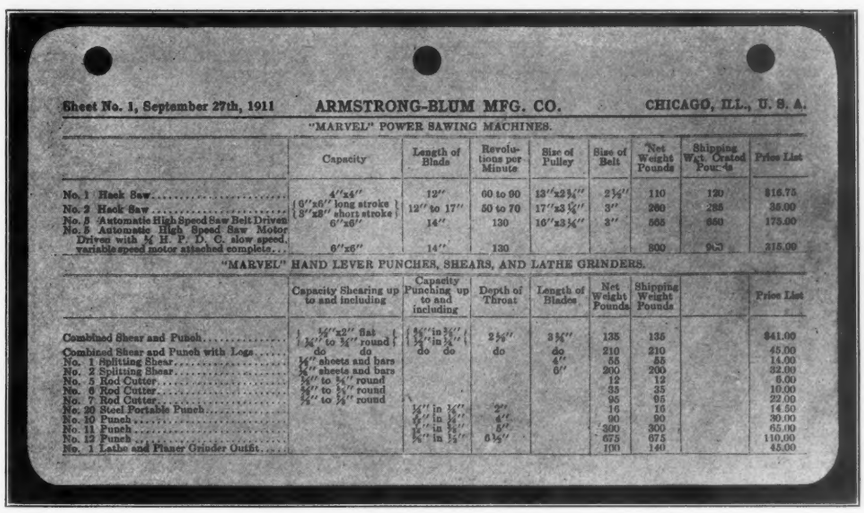
From this it will be seen that 50 per cent more power is put into a 3½-inch bar lathe than into a 4-foot 6-inch boring and turning mill. The weight of the work and table of a boring and turning mill is considerable, and the machine itself is less efficient, the power being taken through one, and often through two pairs of bevel gears.

To obtain the same tool pressure, or take the same cuts, at the same surface speed, would, neglecting the increased friction of the larger machines, require the same horsepower on any diameter; but as larger machines take heavier cuts, and the weight of the moving parts is greatly increased, they, of course, require more power. From the figures given in the foregoing, however, the reverse would appear to be the case in some instances.

* * *

PRICE SHEET FOR SALESMEN

Manufacturers of light machinery sold by jobbers and dealers find it advantageous to issue price sheets printed on thin paper with rounded corners, 4 by 7½ inches perforated, as shown in the reproduction of the sheet issued by the Armstrong-Blum Mfg. Co., Chicago. These sheets fit the loose-leaf price sheet books commonly carried by salesmen, and most of them are glad to add it to their regular lists though they would not think of carrying an extra circular or catalogue.



Sheet No. 1, September 27th, 1911 ARMSTRONG-BLUM MFG. CO. CHICAGO, ILL., U. S. A.

"MARVEL" POWER SAWING MACHINES.

	Capacity	Length of Blade	Revolutions per Minute	Size of Pulley	Size of Belt	Net Weight Pounds	Shipping Wt. Crated Pounds	Price List
No. 1 Hack Saw	4"x4"	12"	60 to 90	12"x3½"	2½"	110	120	$16.75
No. 2 Hack Saw	(6"x6" long stroke (8"x8" short stroke	12" to 17"	50 to 70	17"x3½"	3"	260	285	35.00
No. 5 Automatic High Speed Saw Belt Driven	6"x6"	14"	130	16"x3½"	3"	555	660	175.00
No. 5 Automatic High Speed Saw Motor Driven with ½ H. P. D. C. slow speed, variable speed motor attached complete	6"x6"	14"	130			800	965	215.00

"MARVEL" HAND LEVER PUNCHES, SHEARS, AND LATHE GRINDERS.

	Capacity Shearing up to and including	Capacity Punching up to and including	Depth of Throat	Length of Blades	Net Weight Pounds	Shipping Weight Pounds	Price List
Combined Shear and Punch	½"x2" flat ¾" to ⅝" round	⅝" in ⅝" ½" in ½"	2⅝"	3⅝"	135	135	$41.00
Combined Shear and Punch with Legs	do do	do do	do	do	210	210	45.00
No. 1 Splitting Shear	¼" sheets and bars			4"	55	55	14.00
No. 2 Splitting Shear	⅜" sheets and bars			6"	200	200	32.00
No. 5 Rod Cutter	⅝" to ¾" round				12	12	6.00
No. 6 Rod Cutter	½" to ⅝" round				35	35	10.00
No. 7 Rod Cutter	⅜" to ½" round				95	95	22.00
No. 20 Steel Portable Punch	⅜" to ⅞" round				16	16	14.50
No. 10 Punch		½" in ⅝"	2"		90	90	30.00
No. 11 Punch		⅝" in ¾"	4"		300	300	65.00
No. 12 Punch		¾" in 1"	5"		675	675	110.00
No. 1 Lathe and Planer Grinder Outfit		½" in 1½"	6½"		100	140	45.00

Price Sheet for Salesmen

* * *

STANDARD HEADS FOR SMALL SCREWS

The Engineering Standards Committee (Great Britain) has issued report No. 57, dealing with standard heads for small screws. The report standardizes the heads for small screws in five classes—countersunk, instrument, round, cheese, and fillister. For all classes of screws, the diameter of the head has been fixed at 1.75 times the full diameter of the thread. The committee recommends the adoption of a standard angle of 90 degrees for both countersunk and instrument heads. The depth of the coned portion has been determined at 0.375 times the full diameter of the thread. For instrument-head screws the committee recommends that the radius forming the curved surface of the upper portion of the head be equal to twice the full diameter of the thread. It follows from this that the depth of the curved portion of the head will be approximately equal to 0.2 times the full diameter of the thread. In the case of screws with round, cheese or fillister heads the committee recommends that a plain cylindrical portion having a length not exceeding twice the pitch, be left on the shank immediately underneath the heads of the screws. When determining the depths of the saw cuts or screw-driver slots the committee has endeavored to follow existing practice as far as possible, and has grouped them together in convenient sizes according to the gage of the metal from which the saws used are manufactured. The committee recommends a standard depth of saw cut equal to half the total depth of the head in all cases, this depth to be measured at the center of the head.

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MACHINERY

DESIGN—CONSTRUCTION—OPERATION

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

APRIL, 1912

PAID CIRCULATION FOR MARCH, 1912, 24,986 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

THE UNIT SYSTEM OF MACHINE CONSTRUCTION

A feature of machine construction that has been widely adopted during the past decade, especially in machine tools, is the so-called "unit system." The principle of the system is simply that of dividing a machine into groups of closely related mechanisms and constructing them with independent frames or boxes in which the shafts, studs, clutches, gears, etc., are assembled. These units of mechanisms are assembled on the main frame to form the complete machine. The natural divisions of the engine lathe, for example, are the headstock, tailstock, carriage, apron, feed-box, change-gear box, etc. These, mounted on the bed, require only the lead-screw, feed-rod and legs to complete the lathe. This admirable system has several marked advantages.

In the first place it is the logical development of the interchangeable system of manufacture which has so greatly reduced the cost and improved the quality of manufactured products. The units are made independently in departments suited to the character of the work, by men who, specializing on each particular unit, become experts. Refinements of design and construction are developed that could hardly come into existence in a building shop.

In the second place the units being interchangeable can be replaced by the user in case of accident with a minimum of trouble; they can be removed, returned to the factory for repairs at small expense for freight and handling.

A third advantage to the machine tool builder is the ease with which units can be incorporated in various designs. The builder, say of milling machines, can use the same feed-box in several sizes and styles, thus enabling him to produce a variety of designs at a minimum cost for jigs and fixtures, all in harmony with the general design.

These advantages, particularly the last, are slowly being grasped by the builders of special machine tools. This business, as everyone knows who has ever been in it, is conducted on a close margin of profit, and its returns, when compared to straight manufacturing, are hardly commensurate with the thought and energy required for success. More of the manufacturing element can be introduced by the development of unit designs of speed- and feed-boxes, tool-slides, elevating mechanism, etc., which can be worked into special designs with little trouble. These units can be made in lots of fifty or a hundred, using jigs and labor-saving appliances that are out of the question when making up parts specially for each machine. The reduction in cost and the more even distribution of labor over a given period incident to the unit system should make the conditions of special machinery building easier than they are now.

* * *

CLEAR THINKING AND WRITING

Given good ability, the one faculty that an ambitious man should cultivate is that of expressing his thoughts clearly in speaking and writing. Compared with one of equal ability who cannot express his ideas clearly, the possessor of a good vocabulary has a great advantage. This fact has been recognized in all times, and yet it is not as fully appreciated by many who are striving to rise in the world as it should be. The successful salesman sells goods because of his ability to secure an audience with buyers and to hold their attention. He holds attention because his story is interesting. He talks of the quality of his goods, how they are made, when they can be delivered, the terms of sale, meets arguments in a kindly spirit, and overcomes opposition by attractive manner and expression. That ability is certainly a great asset to any man. Not all of us can be salesmen in the sense of selling goods, but most of us have to market our abilities in some form of service. The man who can make his service appear to the best advantage usually gets the highest wages, other things being equal.

The machinist who can turn out a perfect piece of work in the average time or less, is a man whose ability will be recognized in most shops in the highest wages paid to journeymen. If he possesses the ability to plan a job and to tell how to perform it he will stand still higher and will, in fact, be rated as having executive ability, simply because he can tell someone else what to do.

With the foreman the telling of what to do and how to do it is the principal part of the day's work. The journeyman who aspires to fill higher positions must cultivate the faculty of imparting knowledge to others. If he practices writing out the plan of procedure for all the jobs that come under his observation, he will be surprised to find that the simplest piece of work is generally made up of several elements, each of which must be clearly known before the work can be carried to a successful conclusion. Describing a piece of machinery either orally or in writing develops logical thinking and leads to investigations of the principles of elements which are the fundamentals of all machines.

With understanding comes the joy of mastery and the common desire of broad-minded men to impart their knowledge to others. That imparting knowledge is profitable to the giver is common experience. It is proved by the rapid advancement of many contributors of MACHINERY who have started in a humble way to tell the readers about some interesting piece of machinery and how it was made. Their mental horizons expanded rapidly, and with expansion of mind came better appreciation of the meaning of what they read and the ability to assimilate ideas and use them. Soon, to our regret, they have ceased to write, because their time and energies have become absorbed in the duties of the executive positions to which they have been promoted.

* * *

One of the fascinating subjects to the theoretical engineer is the Schiele curve as applied to step bearings. The curve is a beautiful design in theory to equalize the wear on all parts of a thrust bearing. In practice, however, it is another story. The cost of producing it compared with an approximate form is so high that its advantages are *nil*. A well-known builder of boring mills formerly made the spindle bearings of his mill tables with the Schiele curve, and fitted up at heavy expense to produce them accurately. But after using the Schiele curve bearing for a few years it was abandoned for a conical bearing and plain step, the two approximating the shape of the Schiele curve spindle. The result has been entirely satisfactory and the cost is much reduced.

TARIFF REFORM

Although many American industries have attained their present strength under protection, this result has been accompanied by abuses from which consumers have suffered, and the majority of voters want a reform. They will have their way; but business men who favor a reduction want it brought about in a businesslike way, by a competent tariff commission not composed of politicians. Our machine tool builders in 1908 not only consented to, but favored, a reduction in the tariff on machine tools, and if a similar policy had been adopted by manufacturers generally the present disturbance to business might have been avoided.

There is a marked difference between the position occupied by machinery manufacturers and almost any other American industry, in that a machine usually represents years of thought, labor, experiment and outlay before a single one is sold. Yet this is hardly on the market before its vital points are imitated by foreign manufacturers who, except for the tariff, would be able to undersell the originator in his own market on account of the difference in the labor cost. Freights also favor the foreign manufacturer as the rates to New York City from almost any of the English or German industrial centers are less than from Cincinnati.

Our tariffs should be reduced; but the changes should extend over a period of years so as to enable our manufacturers to readjust their prices and methods to the new conditions. Any radical change in the tariff on machine tools, such as the proposed one to place them on the free list, would result in disaster to the entire machinery and allied industries; and the losses would fall as heavily on the workman as on the employers. Immediate free trade in this industry would mean destruction, not reform.

* * *

TURNING SHAFTS IN TURRET LATHES

Some manufacturers of machinery who have put turret lathes to all possible uses have occasionally met with serious difficulties when trying to turn shafts, say, 1 inch diameter and 30 inches long. The shape of the shaft at the chuck end where the cut is started will be turned round and true; but as the tool travels away from the chuck a quasi-hexagon, octagon or other polygonal shape may be developed under certain conditions, which gradually grows worse, until it is so pronounced at the finish end that ordinary allowances for grinding may not be sufficient to remove the tool marks. Although this is an old trouble, and the causes, and means for eliminating them, were discovered long ago, a knowledge of the facts is not as common as it should be in view of the widespread use of the turret lathe.

Where roller back-rests are in use, the first surmise of course is that one of the rollers is eccentric or worn flat, but other elements more obscure may cause the trouble. A well-known turret lathe builder states that the trouble is wholly overcome by using a back-rest of the old style, which embraces about half the cylinder and is of a dimension fairly close to the size to be turned. But these back-rests are not adjustable, and are subject to roughing up, which becomes a serious trouble. The V back-rests and roller back-rests seem to be superior, notwithstanding the possibility of the work's becoming slightly polygonal at times.

One of the principal elements in establishing the tendency to turn polygonal is produced by the varying depth of cut, which of course is the result of eccentricity of the stock. The effect of varying the depth of chip can be almost wholly neutralized by setting the cutting face of the tool perfectly square to the travel or a trifle "under," so that the variation in radial thrust is reduced to a minimum. The surface of the back-rest should make contact very close to the front edge, and the cutting tool should be set slightly in advance of the back-rest. If the back-rest does not touch the stock at the front, because of being a trifle bell-mouthed, or if the tool stands too far ahead of the back-rest, or again, if the tool is beveled so that the outer edge is in advance of the point, then the stock will spring away from the tool under the heaviest part of the cut. A round-nose tool, or a tool in which the point is behind the cutting edge, of course gives the greatest variation in radial resistance when the depth of the cut varies. This applies to turning cylindrical work in either direction, but the action is especially pronounced in turning away from the chuck when the outer end of the stock runs free.

Attention to these details of setting the tools and back-rests will generally eliminate the tendency to turn polygonal shapes entirely. The case is but another of many in machine shop practice in which apparently minor adjustments play an all-important part in producing satisfactory work.

* * *

THE DISAPPEARING TOOL-CHEST

By A. P. PRESS

Those of us whose heads are white well remember what was the first thing to be done after we had got a new job. That was to hunt up an express man to move the tool-chest. The machinist who did not possess a good set of tools and a good looking chest, even if it did not contain a "mike" or a vernier caliper, was considered a "poor stick."

One of the first requisites for the tool-chest was a pair of good stout handles for each end—handles that would stand a strain of 100 pounds or more. Inside of the chest you would find a 2-pound chipping hammer, a 1-pound or a 1½-pound light hammer, three or four smaller riveting hammers, most of which were homemade; three or four cape chisels, and an equal number of broad-faced chisels for straight chipping; a 12-inch and a 6-inch monkey-wrench; a 24-inch straightedge about ¼ inch thick with one edge beveled down to 1/16 inch or less; and a 12-inch scale usually round at one end and square at the other. These scales were imported from England. A 24-inch scale was beyond the machinist's wildest dreams. Besides there would be in the tool-chest six or eight pairs of calipers; a surface gage with a 4-inch base that weighed about 2 pounds or more, and a standard not less than ⅜ inch in diameter; a hacksaw on which the teeth had to be filed every time it was to be used; and a box level (not a protractor).

If the man claimed to be a millwright as well, as many of the oldtimers were then, there would be an 18-inch level and a plumb-bob with a line around it. Under all circumstances there would be a box of drills or "flats," and one or two choice twist drills, besides an indescribable amount of scrap that invariably accumulated.

Now what does the new man that comes in to-day bring along? He has a little hand-bag, about the size my lady uses when she goes downtown shopping, and inside there will be one or two sets of "mikes" and possibly a full assortment of scales from 9 inches down. There will also be a bevel protractor and a pair of spring calipers, and possibly a chipping hammer about 1½ pound in weight. Of a dozen men to-day, not more than two will bring a tool-chest, and the foreman does not view them with approval. When you have only 3½ or 4 feet of bench room for each man, the space is too valuable to be taken up with a big tool-chest. There are several shops with which I am personally acquainted where the tool-chest is not tolerated unless it is kept under the bench, but it is preferred, by those in charge, to have it left at home.

* * *

STRENGTH OF THICK HOLLOW CYLINDERS

A formula for calculating the bursting pressure of thick hollow cylinders, which agrees closely with the results of experiments undertaken by Messrs. Cook and Robinson, is given in *Engineering*, issue of January 5, by F. van Iterson.

Let P = bursting pressure, in pounds per square inch,
F = ultimate strength of material, in pounds per square inch,
R = ratio of external to internal diameter.

Then

$$P = F \text{ hyp. log } R$$

This formula, of course, is not applicable for values of R which make hyp. log R greater than 1, as in that case the bursting pressure P would be greater than the ultimate strength of the material F.

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NOTES AND COMMENT

One discriminating dealer in second-hand machinery pays more for Eastern tools, claiming that the harder iron used in the East gives appreciably longer life to lathe shears and other sliding parts. This dealer, however, handles only second-hand tools that are in prime condition—those that have been well used and employed on a variety of work which has given nearly uniform wear to the shears, etc.

Milling carbon steel at a peripheral speed of 500 feet a minute and producing a surface like polished silver is what the National Twist Drill & Tool Co., Detroit, Mich., is doing on small drills. A high-speed cutter about 3 inches in diameter, having teeth of 3/16-inch pitch and cut at an angle of 15 degrees, is run at the given speed to mill the drill clearances. The drill is supported directly beneath the cutter by a V-rest and the cutter rotates against the cut. Lard oil of the best quality is used for lubricating.

An international exhibition will be held at Liverpool, England, from May to October. The textile, electrical, machine building, general manufacturing, and shipping industries, as well as arts and crafts, will be represented. The exhibition, it is claimed, will be of international importance and similar to the successful exhibition at Glasgow, where the number of people attending exceeded 11,000,000. Copies of the prospectus and application forms for exhibit space may be secured from the Bureau of Manufactures, Department of Commerce and Labor, Washington, D. C.

A change in the equipment of modern drop-forging plants that is being made in the interests of greater efficiency and better product, is the substitution of steam drop-hammers for board or other free falling hammers. The steam hammers work quicker, are under better control and deliver a harder blow for the same weight of drop. They are not as efficient, however, in the use of power as the mechanically-operated hammers. The steam is not as effectively expanded as in an efficient engine cylinder and there are large wastes in steam lines due to condensation. The power cost is, however, a small item compared to the labor cost and general overhead charges.

Few mechanics have an adequate idea of the great cost of some experimental aeroplane engines that have been built to develop great power with low weight. One came to our notice lately that has cost over $12,000 and is not yet completed. The cylinders are made from solid chrome-nickel steel bars, and are marvels of fine and accurate machine work. The weight of the engine, complete, is about 180 pounds and it develops 65 horsepower when all the seven cylinders are chugging. The cost is in inverse ratio to the weight. To illustrate, take one part made of alloy steel which in the rough weighed 115 pounds; when finished, the weight was 6 pounds and the labor cost was over $250.

It is reported that the White Star Line has commissioned Harland & Wolff, Belfast, to build a transatlantic liner which will be 990 feet long, with a beam of approximately 110 feet, a displacement of 70,000 tons, and a gross tonnage of over 50,000 tons. The liner is to be named the *Gigantic*. It will have twelve or thirteen levels or decks, the highest of which will be 75 feet above the water line. The vessel is to be designed with accommodations for over 4000 passengers, 1000 of which can be carried in the first cabin. The new vessel will be a seven-day boat, provided with a combination of reciprocating and turbine engines. It is stated that a cricket field, tennis court, golf links (?), and ball-room will be included. The cost of the vessel will be nearly $10,000,000.

Pensions are granted by the American Steel & Wire Co. to employes who have reached the age of seventy, and who have been in the service of the company or any of its predecessors for ten years. A pension is also paid to employes who have reached the age of sixty and are physically disqualified for further service, provided they have been employed during the preceding ten successive years. The pensioners are allowed to seek employment elsewhere, should they so desire, and can live wherever they please. Some of the retired pensioners, it is said, are living in England, Ireland, and Sweden, besides in various parts of the United States. The pension fund is maintained entirely by the company without any form of contribution from the employes.

A correspondent of the *Frankfort Gazette* draws attention to what seems to be a rather common practice of some German steel-making concerns. It appears that machine tool builders are practically compelled to accept deliveries of steel, instead of cash payment, in return for orders of machine tools. The great iron and steel works thus place the machine tool makers in a difficult position, as the latter have often to choose between losing a contract or laying up a stock of material which they may not be able to use for a long time to come. Sometimes they are forced to use material which they perhaps otherwise would not employ.

The wonderful effect of harvesting and other farm machinery, on the world's food supply is but dimly appreciated by those who have given it only casual thought. A pamphlet called "The Story of Bread," published by the International Harvester Co., is authority for the following statement that almost staggers belief: "A modern farmer, with the practice of scientific knowledge, and the use of modern machines, can, with three months' labor, raise as much wheat as could an old Roman had he worked ten hours a day, six days a week, for all the weeks of his three score and ten years. In the time of Nero it took four and a half days' labor to raise a bushel of wheat; when the reaper was invented it took three hours; and in the time of Roosevelt it takes ten minutes."

For many years past there has been a tendency to mark cutlery and other goods similar to those produced in Sheffield, England, with the word "Sheffield," in order to convey to the purchaser the idea that they have actually been manufactured in or near Sheffield, and that they carry with them the traditional high quality of Sheffield goods. A fund of $55,000 has been raised, and has been placed at the disposal of prominent citizens of Sheffield to prosecute in all cases where the name "Sheffield" is being fraudulently used as a trademark. It is proposed to increase this fund as occasion may arise. The results of the prosecution will be widely advertised, especially in the localities where the firms using the fraudulent marks are located.

Specialization in industries effects innumerable economies and cheapens production. Centralization of some of the functions of a community increases their efficiency. An exception is electric lighting in the case of large buildings. Many of the office buildings, hotels and other large buildings of New York and other cities have their own lighting plants. The exhaust steam is used for heating in winter and carries nearly as many heat units as the same weight of steam used direct from the boilers. If the lighting is charged at the lowest rate that the central lighting plants will quote, the heat costs nothing; if the heating is charged at the cost of live steam as furnished by the boiler, the cost of the current for lighting and power drops to less than a cent a kilowatt in New York City.

A type of machine construction that is much used in Germany is that employing steel plates and structural shapes for the frames. Castings of simple form are placed between the plates to act as separators and give stiffness and strength where most needed. The advantage of this construction is greatest on special machines of rough character, such as boiler shop tools. The cost of large and complicated patterns is avoided, as is the delay incident to making them and getting the castings. A variety of castings that experience has shown can be largely used are kept in stock, and these are modified by machining where needed. Sometimes a large machine for shearing and punching structural shapes will be built up in this manner in a few days, using plates, angles and gussets principally, that would require weeks if built with cast-iron frames in the usual manner.

THE DIESEL ENGINE*

By S. M. HOWELL†

To save the first cost of the igniting devices used on internal combustion engines and to avoid the additional expense and trouble incident to their employment, is an attainment of great practical value; an engine that is self-igniting and which also embodies other important advantages, is certainly a very desirable form of construction. The fact that the heat of compression is capable of firing the charge in a gas engine cylinder is, of course, a self-evident proposition in the science of thermodynamics, as well as a matter of common experience, and the idea of its utilization for this purpose no doubt occurred to some early designers; but the first prominent example of a self-igniting gas engine was that of Rudolf Diesel, of Germany, and it is probable that his was the first engine in which ignition was thus effected. The Diesel system, however, is not the only method of operation which is capable of self-ignition. Several patents have been secured by other inventors since the date of the first Diesel patent, in which the heat of compression generated by means of an auxiliary high-pressure air pump is used to fire the charge in engines of the impulse or explosion type. In the original Diesel patent, No. 542,846, of July 16, 1895, the inventor does not claim this feature of his motor, but he afterward claimed it in combination with other elements in his patent, No. 736,944, of August 25, 1903. The self-ignition, however, in the Diesel engine, is merely an incident in the operation of the cycle. The motor as a whole differs in its operative principle from all other gas engines, belonging to that general class known as the continuous combustion type. This type was first exploited many years ago by a number

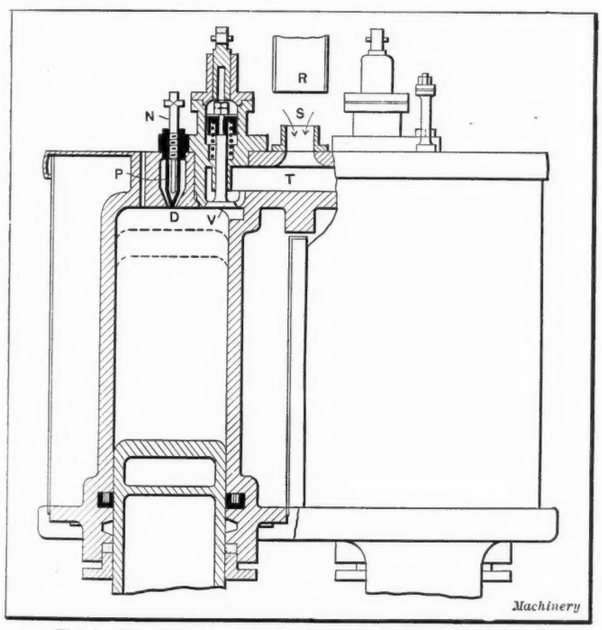


Fig. 1. Diesel Engine using Oil Fuel—U. S. Patent No. 542,846

of inventors whose productions never came into general use, and it was for a time displaced almost entirely by the impulse form of gas motor.

The primary idea of the Diesel system is to compress a charge of air by the in-stroke of the piston, to such a degree that the resulting heat will equal the highest temperature subsequently attained by the burning charge. The fuel is injected during a first fractional part of the power stroke, and is self-ignited and burned in a volume of air considerably in excess of the quantity actually required to consume it. By this means the mean working temperature of the cylinder is so reduced that the use of a water jacket is unnecessary. Thus the loss due to the abstraction of heat by water cooling, is avoided, and the highest degree of efficiency is secured from the thoroughly consumed fuel.

In considering the theory of this system of operation it would seem at first thought that to produce by means of compression alone a temperature equivalent to that of normal combustion, would require an excessive degree of pressure, so high indeed as to be altogether impracticable; and it may also seem that the heat generated by the combustion of the fuel would simply be added to that already existing in the body of compressed air, and that the resulting temperature would be still higher. Ordinarily this would be the case—that is, if the charge of fuel could be instantly introduced, but this action is not contemplated by the theory and does not occur in practice. Nor is the degree of initial compression as high as would be required to produce a temperature equal to that of combustion under ordinary conditions. The reasons for this are, first, that the burning charge is diluted,

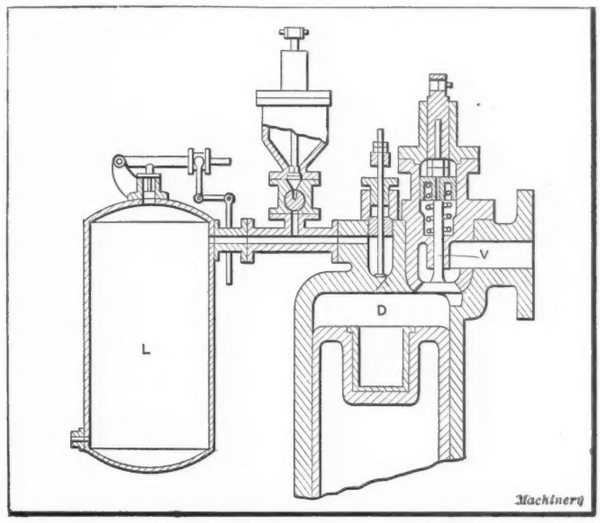


Fig. 2. Section of Diesel Engine having Compressed Air Tank for Starting

and the heat greatly modified by the superabundance of air, and second, that the fuel is forced into the cylinder while the charge is expanding on the power stroke, and is so regulated that the heat added by combustion is only sufficient to counterbalance that lost by expansion as the piston moves forward. Thus both the temperature and the pressure of the initial air charge are maintained, without material change, to the point of cut-off. This point is determined by the governor or control lever, and from thence to the end of the power stroke the pressure falls in an adiabatic curve, and the burnt gases are finally exhausted at the temperature of the atmosphere. The heat is absorbed and transformed into work by the expansion of the charge from the point of cut-off to the termination of the stroke.

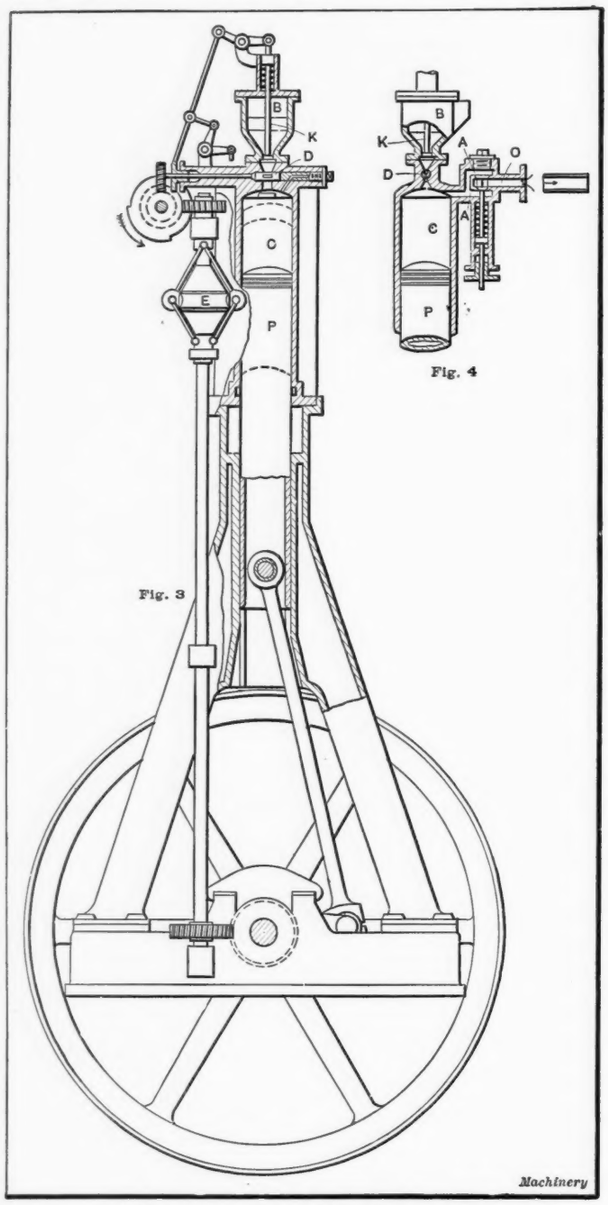
The object of the system is to promote a more perfect combustion, and to secure a working fluid of comparatively low temperature, expanded to the full limit of its useful effect. It should be observed, however, that while this is the theory of this celebrated motor, it is not fully carried out in the prevailing practice of the present day. A theory can seldom be accurately followed, and must always be subject to the requirements of practice. In the models originally demonstrated by the inventor, the initial air charge was compressed to 1500 pounds per square inch, with a resulting temperature of 1500 degrees F., and the fuel admission was accurately adjusted to maintain the theoretical conditions; but in many cases the Diesel engines now built depart somewhat from the first standard in this respect, and operate partly upon the system of the impulse or explosive cycle. The water jacket discarded by Diesel is now generally restored, and a pressure of 500 pounds per square inch is considered the proper degree of initial compression to secure the best all-around results in practical service. The thermal efficiency may be slightly reduced by this practice, but durability and ease of lubrication are improved by it, and commercial efficiency is secured to a more satisfactory extent than would be the case if the

* For further information on this and kindred subjects, see MACHINERY, February, 1912, engineering edition: "Points in the Design of Two-Stroke Cycle Engines," and also the previously published articles there referred to.

† Address: Oroville, Cal.

exact conditions demanded by theory were made the governing motive of the design.

For the purpose of automatic ignition, the extent to which the initial compression of the air charge should be carried depends upon the character of the fuel—that is the temperature at which it ignites; but as the fuel is usually crude oil or one of its heavy constituents, such as distillate or kerosene, there is but slight difference in the igniting points of these liquids. It is, of course, absolutely essential that the injection fuel be instantly and unfailingly ignited, and for obvious reasons it is certain that the compression of an engine in continuous use will not always be as high as when first



Figs. 3 and 4. Diesel Engine using Solid Fuel

installed. It is, therefore, good policy in designing a Diesel engine to take the safe side in this matter, by providing a degree of compression which is sufficiently high to include a margin of safety, in anticipation of the probable effect of wear and use under unfavorable conditions.

The manner in which this cycle differs from that of the more familiar impulse or explosion type of motor, and the chief reasons of its greater efficiency, may be seen at once by comparison. In the impulse motor the volume of the clearance space usually equals about one-third of the piston displacement. The in-stroke compresses the charge of mixed air and gas to, say, 75 pounds per square inch. At the moment this action is completed the charge is fired, and the pressure instantly rises to perhaps 300 pounds per square inch and a temperature as high as 3000 degrees F.; the gases are exhausted at the termination of the stroke at a temperature of at least 500 degrees. This makes the mean working temperature quite high, and a considerable portion of this heat must be absorbed by the water of the jacket in order to moderate the temperature of the cylinder and piston.

In a Diesel engine, however, the clearance does not exceed 7 per cent of the piston displacement, and the in-stroke forces the entire body of the air drawn in on the previous out-stroke into this space, at a pressure of 500 pounds and a temperature of about 1000 degrees. The injection of fuel begins with the power stroke and continues (if the engine is running under full load) until the piston has completed about one-fourth of its outward movement. The quantity of fuel is just sufficient to maintain the original pressure during the combustion interval, that is, from the beginning of the stroke to the point of cut-off. The volume of air is about double the amount required to consume the fuel, and the resulting temperature is correspondingly low. From the point of cut-off the charge expands to the end of the stroke, where it is exhausted at low temperature and pressure. As a result of this method of operation, the mean working temperature of the charge is lower than that of any other gas engine cycle. Consequently less heat is taken up by the jacket or lost by radiation, and a larger proportion of the heat energy of the fuel is utilized for the production of power.

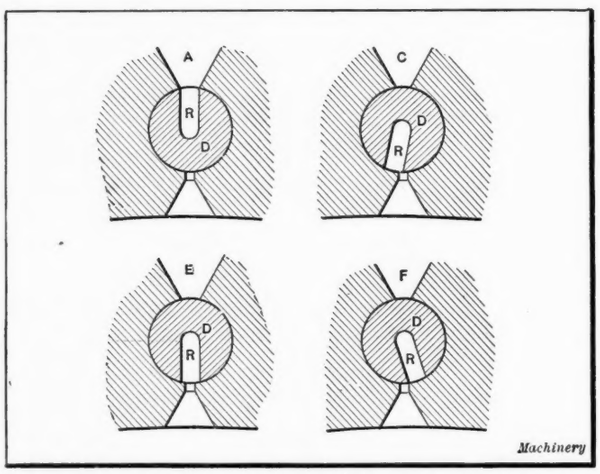


Fig. 5. Section showing Action of Valve D, Figs. 3 and 4

The means of introducing the fuel into the cylinder of a Diesel engine in a suitable physical condition and in a regulated amount is one of the most important features in the design and operation of the motor, and has received a large share of the attention given to the construction of these engines by engineers and inventors. Several methods have been devised by the original inventor of the engine, as well as by others, and two or three of these are now in use. In most cases the engine comprises an auxiliary air or injection pump, capable of producing a degree of pressure considerably in excess of the cylinder compression; this higher pressure is used to force in the liquid fuel through a minute opening controlled by a needle valve in the cylinder head. In one arrangement the fuel opening is located at the bottom of a cup-shaped chamber in the head of the cylinder, the stem of the needle valve standing in a vertical position. This chamber is in communication with the injection pump, the suction stroke of which draws a charge of oil fuel into the chamber. The lift of the needle valve is effected by a device operated by a cam on the main shaft of the engine, and the extent and duration of this lift, and also the quantity of fuel drawn into the chamber, is controlled by the governor. At the proper moment the needle valve opens and the high-pressure air drives the oil, in a finely divided spray, into the hot-air charge within the cylinder.

In the first American patent of Diesel, No. 542,846, the mechanism used for delivering the oil fuel is practically the same as that just described, and is shown in Fig. 1. This

illustration shows an engine with two cylinders just alike, and designed to be connected to the same shaft. The crank-pins are in the same line, and the movements of the reciprocating parts are parallel. One cylinder is shown in section and the other in elevation. The spring closed valve *V* is used for both admission and exhaust; *R* is the exhaust pipe, and just below the open end of this pipe is the nozzle *S*, communicating with the passage *T* which leads to the valves *V* in both cylinders. Combustion takes place alternately in the cylinders, producing a working stroke at each revolution, and since the exhaust follows immediately after the drawing in of the air charge, the valve *V* remains open during a full revolution and is then closed during a full revolution. At *D* is shown the fuel nozzle; at *N* the needle valve; and at *P* the fuel cavity into which the charge of oil fuel and a small body of highly compressed air are first delivered by the injection pump and then passed through the nozzle *D* by the needle valve and sprayed into the heated air of the cylinder charge in the manner already described. The exhaust is nearly cold and of nearly even tension with the atmosphere, and the return of the piston drives out the products through the nozzle *S* into the open end of the exhaust pipe. The fresh air for the next stroke enters the same nozzle from the open space around it.

The claims of the American patent of July 16, 1895, were previously granted in England, April 14, 1892, and expired by limitation April 14, 1904. The three claims broadly covered the principles involved in the operation of the cycle as above described, and as the field is now open to all who wish to use the Diesel cycle in combination with their own designs, this patent is the key to the situation as far as general principles of operation are concerned. The specifications of this patent were largely devoted, however, to a description of certain methods of using solid fuel (coal dust), as then contemplated by the inventor, and we will consider this feature further on.

The second American patent of Diesel, Reissue No. 11,900, dated April 2, 1901, contemplated the employment of solid fuel injected with a mixture of gas and air in order to insure instantaneous ignition and more complete combustion. It also described a method of starting the engine with compressed air stored in tank *L* in Fig. 2, the compression having been effected by the engine on a previous run. In this arrangement, a lever-operated clutch controls a system of shifting cams, by which, when the engine is first started, the valve *V* is made to admit the compressed air from tank *L* to the cylinder at each out-stroke of the piston, and to exhaust the same upon the in-stroke. After a few revolutions the flywheel acquires sufficient momentum to effect the compression of the charge, and by a movement of the clutch-lever, the action of the cams is so altered that the valves are operated in the usual manner, and the regular cycle is taken up. This patent specification further provides for a method of automatic ignition without the use of the extra high-pressure air pump. In this modification ignition is effected as follows: The opening of the fuel valve is delayed until the piston has receded slightly from the dead point, and the pressure first produced by the initial compression of the air charge has fallen somewhat. The fuel valve then opens and the air previously compressed in tank *L* forces in the fuel charge as usual. The remainder of this patent specification is devoted to descriptions of burners, fuel spraying devices, etc., evidently designed in anticipation of their possible adoption by others, but probably never constructed.

The next Diesel patent is No. 708,029, dated September 2, 1902. The object of this specification is to reduce the usual size of the auxiliary air or fuel injection pump. For this purpose the pump receives its air from the compression space of the engine cylinder at a high pressure, and thus a pump of much smaller size may be employed than would otherwise be necessary. The next patent, No. 736,944, dated August 25, 1903, relates to the construction of a two-cycle engine and certain means of scavenging the cylinder of the burnt gases before the admission of the fresh air for the succeeding charge.

The last patent of this inventor, No. 890,620, dated June 16, 1908, deals with the introduction of the liquid fuel, the leading idea of this specification being to heat the oil fuel and to saturate it as far as possible with highly compressed air, prior to its admission to the cylinder of the engine, in order to facilitate atomization and promote a more thorough admixture of the fuel with the air of the charge. The oil fuel is continuously pumped into a receiver where it is submitted to the action of air at the working pressure of the engine, and then delivered to the cylinder by the means already described.

Figs. 3, 4 and 5 of patent No. 542,845 show the construction of the original Diesel engine designed for the use of solid fuel. The stroke is long in comparison with the bore, and the compression of the charge is very high. The air is drawn in on the suction stroke at valve *O* (as in the engine shown in Fig. 1), and this valve serves also for the exhaust. The powdered fuel is supplied to the hopper *B*, and is fed by valve *K*. The lift of this valve is controlled by the governor, and the consumption of fuel is thereby proportioned to the demand for power. The delivery of the fuel to the combustion chamber is effected by the rotating plug valve *D*, shown in Figs. 3 and 4, and in transverse section in Fig. 5. This valve has a slot *R*, on one side, and is revolved by the worm-gear shown in Fig. 3. When in position shown at *A*, in Fig. 5, the slot *R* receives a charge of fuel from valve *K*, and while in positions, *C*, *E*, and *F*, delivers the same to the cylinder during the combustion interval.

The inventor states in regard to the use of coal dust fuel that, "the residues of combustion being suspended in a finely divided state in the whirling gases are blown out with the same." If such an engine was ever successfully operated, however, it was probably run at a slow speed.

The Diesel cycle is easily adapted to the use of gas fuel of almost any description. The injection pump receives and compresses the gas to about 750 pounds per square inch, and the injection valve operated under control of the governor, delivers this compressed fuel to the cylinder.

* * *

AN ANALYSIS OF LATHE ACCIDENTS

The gathering of statistics by labor inspectors and inspectors of factories is accumulating a vast store of interesting information. In England, for example, a very complete report has been published covering facts elicited on inspection and in reports, in the Northeastern division of the work of factory inspection.

The total number of accidents reported with lathes in the year 1910 was 670. The classification of the sources of these accidents and the numbers in each group are given in the following table:

From the driving belt of the lathe	24
From the cone-pulley, or belt of the lathe proper	46
From spindle-gear and back-gear	17
From the change gears at the headstock	17
From other gears in apron and feed mechanism	8
From the driving dog	71
From the faceplate or chuck	23
From projecting set-screws about the lathe or work	8
From the tool point or article being turned	297
From the flying chips, or articles being turned flying out	127
From other causes, including falls upon the workmen	32
	670

It is interesting to notice that nearly one-third of these accidents occurred in connection with the work being turned; next to these are the accidents incident to the dog or driver catching the arm or clothing of the workman, and doubtless the chuck or faceplate accidents might be taken together, making up nearly 15 per cent of the entire list.—*The Journal of Industrial Safety.*

* * *

To illustrate the progress of the introduction of machinery in different manufacturing industries, a notable example is cited in a factory in Waterville, Me., where paper pie-plates such as are used by bakers are made in automatic machines that cut, form and emboss plates, turning them out at the rate of 840,000 per day.

PREVENTION OF INDUSTRIAL ACCIDENTS*

By FREDERICK REMSEN HUTTON†

Prof. Frederick Remsen Hutton‡

It should require no argument to prove that an accident in a shop or factory is an economic blunder. It costs the owner, the victim, and the community more to produce the staple article in that establishment than if accidents were prevented. The owner or manufacturer pays at least four costs.

1. The proper compensation of the victim who for a longer or shorter period is unable to earn wages.

2. The cost of litigation where questions arise respecting the responsibility for the accident; or the cost of liability insurance, if the owner follows this method of protecting himself from more costly attack.

3. The cost of the diminished rate of production which follows the nervous shock to everyone who witnessed the accident or ran to the help of the sufferer.

4. The cost of the time to train a new operative to the speed and skill of the disabled one, and such loss as there may be from defective work in that process.

If the seller properly charges these costs to the prime costs of production, he is unable to meet the competition of a rival who has no accidents. In the second place, the community as a whole wastes its resources in the care of the disabled one in the hospital and the charity doled out to any dependents he may have. The community suffers indirectly also, because the victim's children are held back from their full schooling in order to go to work. In the third place, the victim himself spends his savings, laid aside for old age, to say nothing of the pain, the sorrow, the disappointment, the broken spirit, and the quenched ambitions, which the victim has to bear.

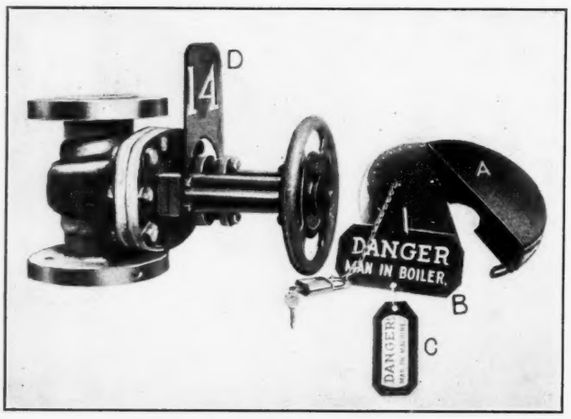


Fig. 1. Safety Lock for Steam Valves

Are industrial accidents preventable? The answer must be conditioned upon the definition given to an accident. An industrial accident may be defined as something which happens to a man, or to a machine, which incapacitates either for the process of production. The accident to the machine may involve an accident to its operator, or he may escape. So far as the operator is concerned, an industrial accident is one by which a mechanical force acts upon the non-resisting tissues or structure of the human body and wounds, bruises, lacerates, or crushes such parts of the body as are in the path of that force. It is the mechanical forces which are responsible for the injuries in industrial accidents. The accident to the machine may be the result of a poor design or of a failure in the material of a properly designed part, from an excessive stress. Prevention of accidents would therefore seem to be a matter which concerned the designer, the inspector, and the works-manager, foreman or superintendent.

The accidents outlined above are in the nature of a sudden disablement. It is no less the duty of the designer and manager to take steps to prevent a gradual disablement, or a premature wearing out of the wage-earning capacity, by slow physiological causes incident to the character of the work; or, to put this in other words, the producing interests need as an economic proposition, to have their human factors in the "pink" of physical condition. They should take care that no conditions in the works itself are responsible for lowered vitality.

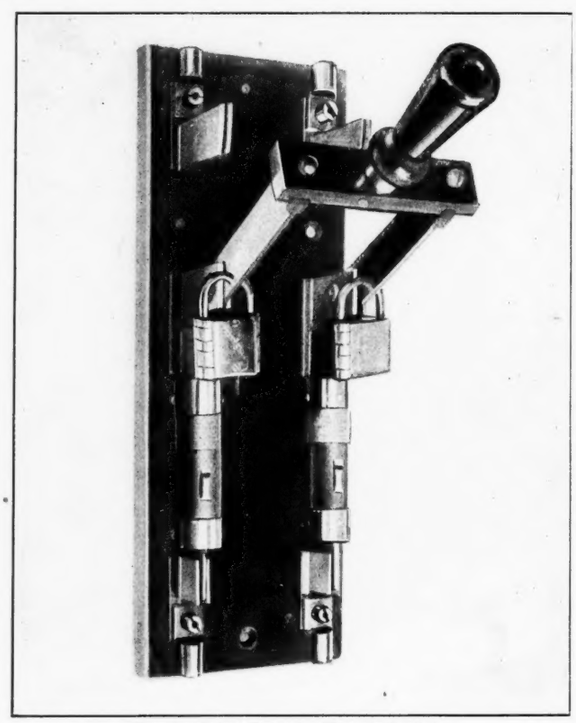


Fig. 2. Safety Lock for Electric Switch

Preventing Accidents in Boilers, and around Engines and Motors

If the foregoing contentions are sound, the motor energy on which all modern production is based, is the prime cause of industrial accidents. Accidents do not happen when the works are shut down. It is so common to surround the moving parts of the power plant by railings, that it seems scarcely necessary to illustrate safeguards in this class. A disaster, however, hangs over the workman around a boiler, which the safety device shown in Fig. 1 seeks to prevent, and against which it has been found entirely effective. This device for preventing a steam valve from being opened upon a line where

The illustrations used in this article have been furnished by the American Museum of Safety, 29 West 39th St., New York City.

* For previous articles on safety devices and accident prevention published in MACHINERY see November, 1911, number and the articles there referred to.

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‡ Prof. Frederick Remsen Hutton graduated from Columbia University in 1876. From 1877 until 1907 he was professor of mechanical engineering in Columbia University. In that year, he was made professor emeritus and entered consulting engineering practice. From 1883 to 1906, he was secretary of the American Society of Mechanical Engineers and was president for the society year 1906-1907. He was then made honorary secretary of the society in recognition of his efforts and success in building up the society from its early beginnings until it moved to the great engineering building on 39th St., New York. He is the author of "The Mechanical Engineering of Power Plants" and "The Gas Engine." In 1911 he served the city of New York as consulting engineer, and is consulting engineer and chairman of the technical committee of the Automobile Club of America. He was one of the persons who early realized the significance of the protection of the workman from the accidents of his occupation in factory and shop. He is vice-president of the American Museum of Safety, chairman of its committee on exhibits and of its board of award of medals. He was for some time also president of the Industrial Safety Association, organized with a special view to the promotion of safety devices in the design of tools and machinery. He is much in demand as a lecturer on this special subject, particularly among the student branches of the American Society of Mechanical Engineers. He is also greatly interested in the problem of good roads and the philosophy of national highways.

people are at work, consists of a sheet-steel casing which fits around the handwheel. It is locked in place, and the key given to the man most interested. The engine down the line on which men are working cannot be started; steam cannot be turned into a boiler within which a man is working; acid cannot be turned into a tank or vat within which repairs are in progress; and a wide group of most distressing accidents are precluded where this safeguard is used.

Fig. 2 shows a safeguard identical in principle and operation where the danger may come from an unauthorized closing of an electrical switch which the repair-man opened when he went to work. The key of the padlock is, as before, in the pocket of the man most interested, and the current cannot be turned on the line until he unlocks the lock.

The next great avenue of disaster is to be found in the belts or gears through which power is passing. The main belt is usually massive enough to act as its own warning sign. The smaller transmissions, however, are those with which the workman is usually more intimate, and from which his greatest danger arises.

In Fig. 3 is illustrated a form of safeguarding against belt accidents, and, of course, the same principle can be extended

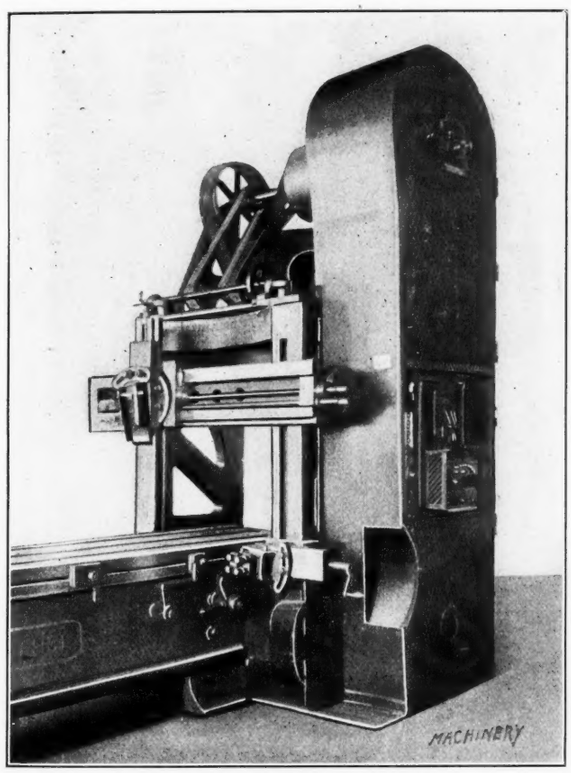

Fig. 3. Guard over Belting and Gears

to gears. A slippery floor or a loose end of a garment may be the cause of throwing a man into the path of the belt, and he may be maimed or killed before the motion can be stopped.

The wood-working or pattern shop is a place where dangerous cutting edges are moving at high speed. These conditions make the circular saw, the jointer or buzz-planer, the molder or sticker, and the band-saw, sources of most distressing accidents, which seem almost worse by reason of their suddenness of attack without warning. Fig. 4 illustrates the trend of modern prevention of accidents of this kind. The lower part of the band-saw is completely encased, and the upper wheel covered with a guard. The accident from the breakage of the saw, and the danger to the forehead of the workman are practically eliminated. He can still, however, lose a finger in the danger zone of the tool. Improved designs of cutter-heads for planers have greatly reduced the dangerous character of the accidents which happen about it, and many forms of guards for the villainous circular saw have been widely installed.

Preventing Accidents in Punch Presses

The punch for boiler and bridge plate is not in itself so very dangerous a tool, but Fig. 5 illustrates a principle of actuating such tools which will make them still safer. Without going into the detail of mechanical construction, it will be plain that by using the electrical wire to put the punch into commission, the fingers of the workman can be kept entirely outside of the danger zone, and he is much less liable to accident than when the design compels that the clutch be thrown in by a second man who may not know just exactly where

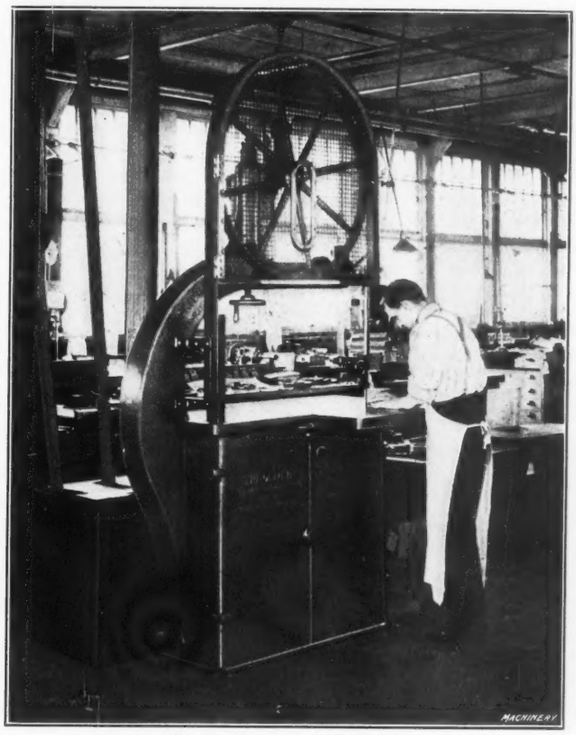

Fig. 4. Guards for a Band-saw

his comrade's fingers are. Probably, however, the most dangerous of the tools in the punching class are the ordinary punch presses used in stamping and drawing sheet metals and similar work. If the ram reciprocates continuously, and the workman feeds the stock by hand, there is always the danger that something will distract his attention, resulting in his leaving a finger where the stroke of the ram can catch it. The designs in Figs. 6 and 7 show a collapsible guard forming a safety device, the intention being that the fingers of the operator

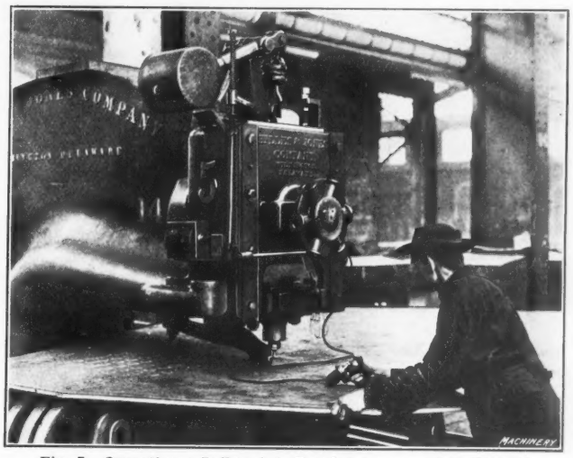

Fig. 5. Operating a Boiler-plate Punch by means of an Electric Hand-switch

shall never get within the guard, while it gives freedom for presenting the stock to the press. Other forms of safeguards cause a steel finger to sweep over the die of such a press, just as the ram descends, forcing the careless finger out of the danger area. A recent clever inventor has proposed to electrify the die as the punch starts to descend, so that any man whose fingers rest on it will get a sharp shock, and automatically draw the fingers away, due to the involuntary contraction of the muscles.

Guarding Emery-wheels

The emery-wheel is a dangerous center of possible accidents. The danger is first from a bursting of the wheel, either by the pressure of the work at the periphery of the wheel, or, more rarely, simply from the action of the centrifugal force. A two-fold safeguard against these accidents can be secured by the use of large disks or washers which grip the wheel at a considerable distance from the revolving axis. If, further, the wheel is thicker at the center than where the washers bear, the danger of a centrifugal flinging of the parts of a broken wheel is materially lessened. Furthermore, the wheel can be covered, except just at the working sector, by a steel guard strong enough to keep in any fragments of the wheel if it should burst.

Fig. 9 shows a safeguarded emery-wheel with the belt protected within a steel shield, and the eyes of the workman shielded by screens either of glass or of fine wire mesh. If

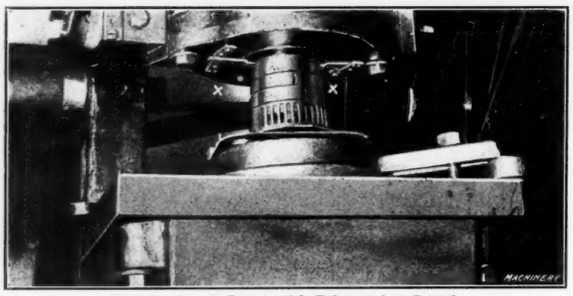

Fig. 6. Punch Press with Telescoping Guard

exhaust currents of sufficient strength to overcome the centrifugal tendency of abraded particles are led away from the wheel, the respiratory tract of the workman is saved from the slow deterioration which it would otherwise suffer.

Miscellaneous Safeguards

The lathe, working on small diameters, or with work in its chuck or on its faceplate, is particularly liable to entangle the sleeve of the workman and break or lacerate his arm. In Figs. 8 and 10 are shown two suggestions for safeguarding the man. The drum *A* in Fig. 8 should keep his clothing from the projecting points of the chuck or faceplate, while

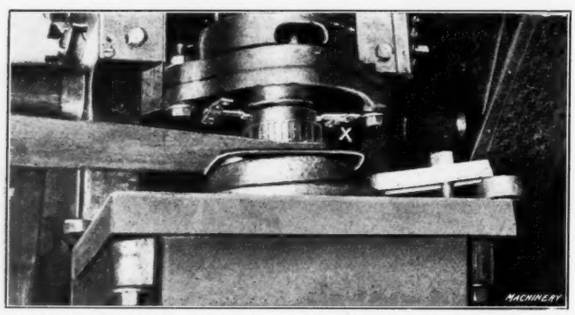

Fig. 7. Punch Press Guard in Fig. 6 with the Ram in its Lower Position

Fig. 10 shows how the common dog can be prevented from his vicious biting.

It is not the custom in the United States to make such common use of women in the shops as the German practice does. The safeguarding the women's hair from being caught in belts or other moving parts should, however, not be neglected. The electrical zone surrounding a fast moving belt is particularly fatal to loose strands, and the entanglement of hair between a belt and a pulley can result in a most distressing accident, which is usually severe enough to be fatal. The wearing of close-fitting caps, covering all of the hair, prevents accidents of this kind.

Accidents in the shop do not originate alone in the danger zone of a power driven tool. The process of chipping often sends a flying particle with considerable force over quite a distance, and the delicate tissues of the eye can easily be pierced by such a barbed missile. In Fig. 11 is shown a safeguard in simple form; a screen of burlap is stretched upon a light frame in the path of such steel particles. The fibrous character of the screen catches what is thrust against it, and the particles drop harmlessly to the ground.

It must not be overlooked that the mechanical force which may strike a man down is not alone manifest or developed at the operating point of the tool. The means of transportation within the shop and about the yard, when operated by power, can be as fatal as the machine tool. The door into

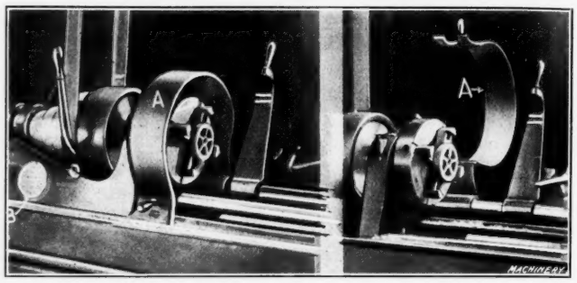

Fig. 8. Guard for the Lathe over Faceplate or Chucks

one of the plant buildings may open directly upon the line of a railway. On a stormy day when the wind is high, or late in the afternoon when the shop is bright, but outdoors is dark, a man may step from the door directly into the danger zone of the railway. He may be intently thinking of something

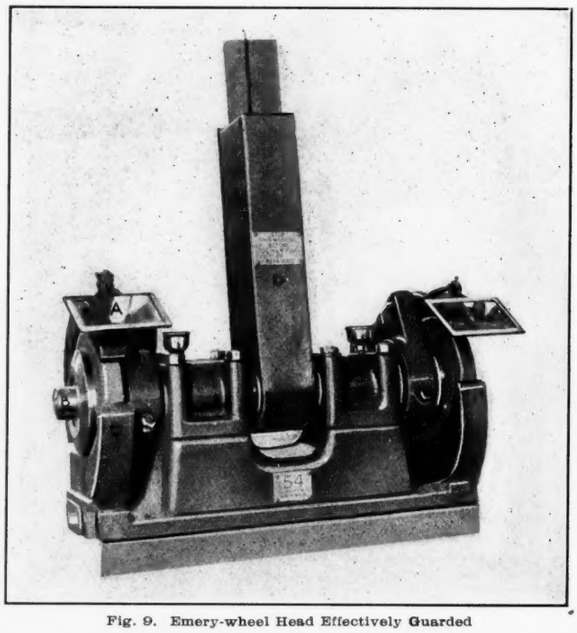

Fig. 9. Emery-wheel Head Effectively Guarded

else, or young lads may be full of the thought of release from toil at the end of the day. The simple expedient of a gate which shall compel a man who comes out through the door to turn and face parallel to the building before he attempts to cross, will at least direct his attention to the danger of the

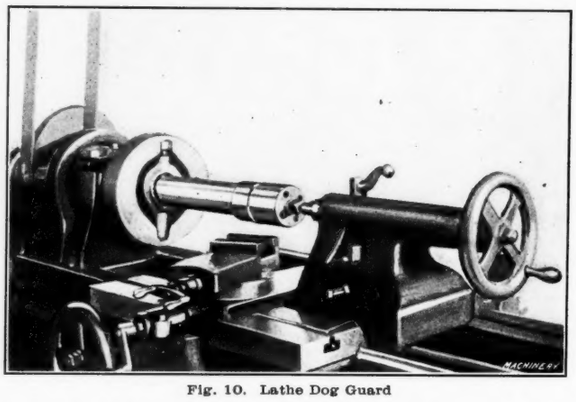

Fig. 10. Lathe Dog Guard

railway line by compelling him to pass around the end of the gate.

The workman whose business it is to oil shafting may meet with an accident by placing his ladder at rather an acute

angle with the floor, and a slippery surface may permit the ladder to fall, bringing the man and his tools to serious injury, particularly if he should fall into moving machinery. It is a good safety device to equip the foot of such a ladder with large contact areas (Fig. 12), and to fit this with a rubber or other surface of high frictional resistance. The protection of traveling cranes, of hoistways and hatches, and of safety hooks and gangway railings, all belong in this general class.

Interlocking Safety Devices

It will be apparent, however, from a consideration of most of the foregoing devices for safety that, even when they are

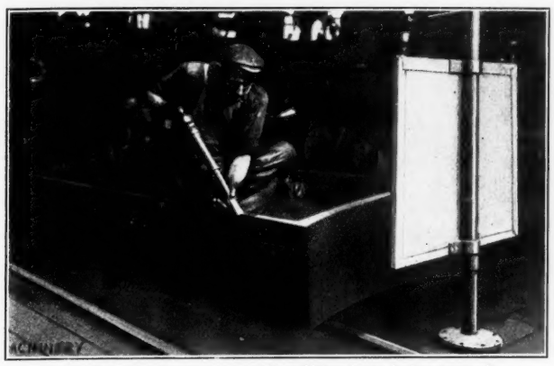

Fig. 11. Screen for Preventing Chips from flying around

used, it is entirely possible for industrial accidents to occur if the workman is careless or uninterested. The highest principle in safety devices is that which in other departments of engineering is called the "interlocking" principle; that is, it may be made mechanically impossible for the operator to have his fingers in the danger zone and have the tool set in motion while his fingers are there. This principle is introduced in two ways. The first is to have the engaging device require a concurrent action of both hands, in order that the machine

Fig. 12. Large Special Feet for Ladders, with Rubber Soles to increase Frictional Resistance

may function. In a press, for example, it may be arranged so that the belt has a tendency to pass to the loose pulley unless a counterweight attached to the shifter is held in a certain position by the right hand. When the right hand has gripped this one lever, it still requires that the left hand shall throw the clutch lever to make the machine operate. Obviously, the workman has no hand free to put in the path of the plunger of the press. The engagement may also be pneumatic, and require that two valves be opened, one of which is worked with the right hand and the other with the left.

The second interlocking principle is applied in centrifugals or kneading machines which are fitted with a cover. It can easily be made mechanically impossible to throw on the power until the protecting lid has been closed down over the working parts. When this has been done, the belt may be shifted or the clutch thrown in. Conversely, when the clutch is in or the belt is driving the machine, the lid cannot be lifted until the power has first been shut off. For the machines to which this principle can be applied, there is nothing additional to be desired in the way of a safety provision.

It is, however, impossible to apply interlocking to all machines, and there remains, therefore, the necessity for getting the workmen interested in preventing accidents. One of the most satisfactory agencies to this end has been the formation of Safety Committees in the works, of which the workmen themselves are made members in rotation, serving with a certain number who do not change from week to week. While it is true that no soldier makes a good captain until he has first served as a private, it is equally true that no man makes so good a private as one who has carried the burdens of a captain. Service on the Safety Committee and familiarity with the line of thought which reaches after safety, makes the men themselves far more willing to take precautions.

We need an educational process which shall, on the one hand, inform the manufacturer as to what safety devices and systems of shop rules have worked well in other plants, and on the other, instruct the men as to the precautions and safeguards which they have a right to expect in their plant. The labor union may very properly exert itself to protect its members by an insistence upon adequate provisions for safety. The factory inspector may properly insist that every works manager lives up to that standard in safety matters which has been found practical in other establishments of the state.

* * *

The Machine Tool and Engineering Association of Great Britain announced at its last annual meeting that eighty firms had joined the association. A communication had been received from the Home Office, one of the governmental departments in Great Britain, with respect to the question of adequately guarding the gears of machines. It was stated in this communication that British firms had lost several orders owing to the inadequacy of the guards over gears, and that machine tool manufacturers in other countries supplied their machines with better guards. A prominent man in the machine tool trade, speaking about the way in which some of the gears and parts were indiscriminately arranged around a machine, to the danger of the operator, suggested that the builders should look at the human frame as a model to which to build their machines, since in this all the important elements are carefully concealed within perfect guards. A designer, he intimated, should make a machine a pleasing thing to look at besides being an article of utility. Mr. Walter Deakin of Messrs. H. W. Ward & Co., Ltd., called attention to the fact that the reason why the British mechanical industries were not in the lead, as they had been in the past, was chiefly due to the narrow view that the members of the trade had entertained. They had, he said, rather kept to themselves and thought that it would be the best policy to cultivate their own little patch, without attempting to recognize the general bearing of questions concerning the whole industry. Evidences, however, indicate that this feeling is disappearing among British manufacturers.

* * *

Radium emits three kinds of rays which for convenience are called alpha, beta, and gamma rays. Of these the gamma rays, which greatly resemble the Roentgen or X-rays, are of tremendous penetrating power. It has been possible to obtain fine photographs with these rays through 12 inches of steel. The alpha rays emitted by radium are in reality small particles of matter that can be detected when the radium is exposed to a zinc sulphide screen; the bombardment of the screen by these particles, which travel at a very high velocity, produces scintillations which under a magnifying glass, look like millions of shooting stars or sparks. Through the constant giving off of particles, the radium atom gradually breaks up, but the process is so slow that only one-half of the atom is broken up in about 1300 years.

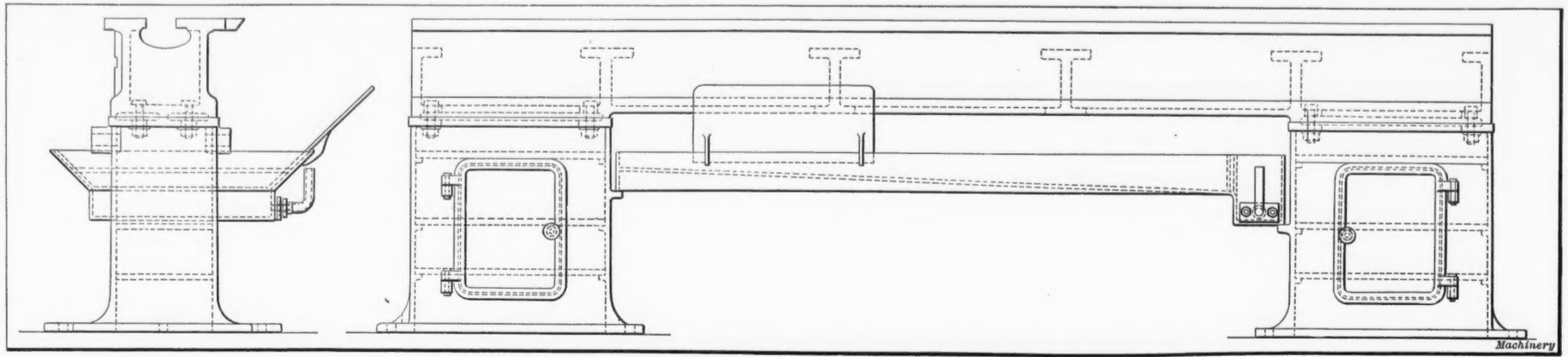

Fig. 1. Lathe Bed supported on Cabinet Standards or Legs with Provision for Lubricating the Cutting Tool

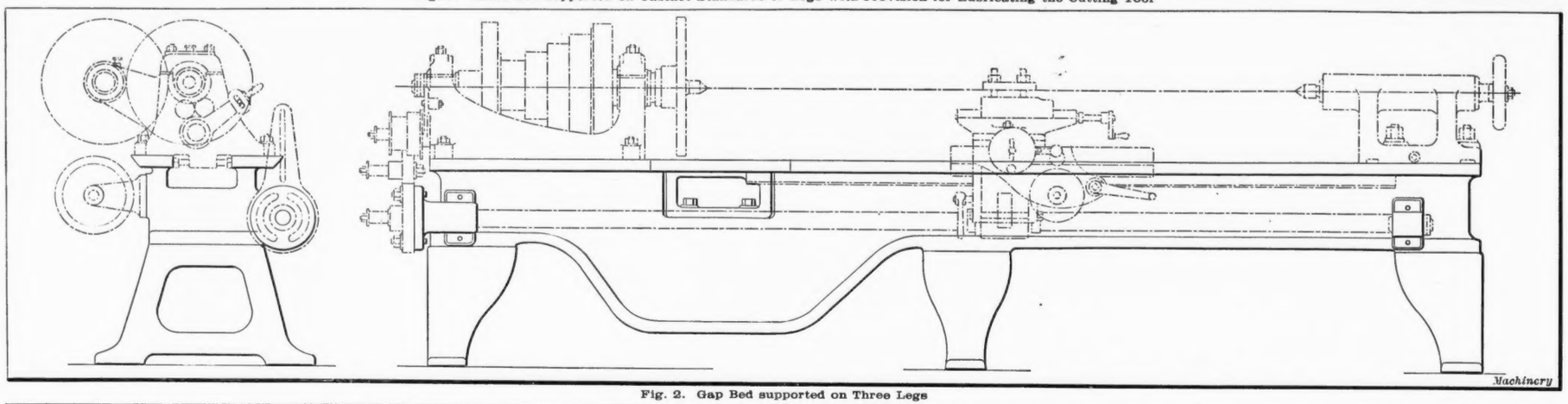

Fig. 2. Gap Bed supported on Three Legs

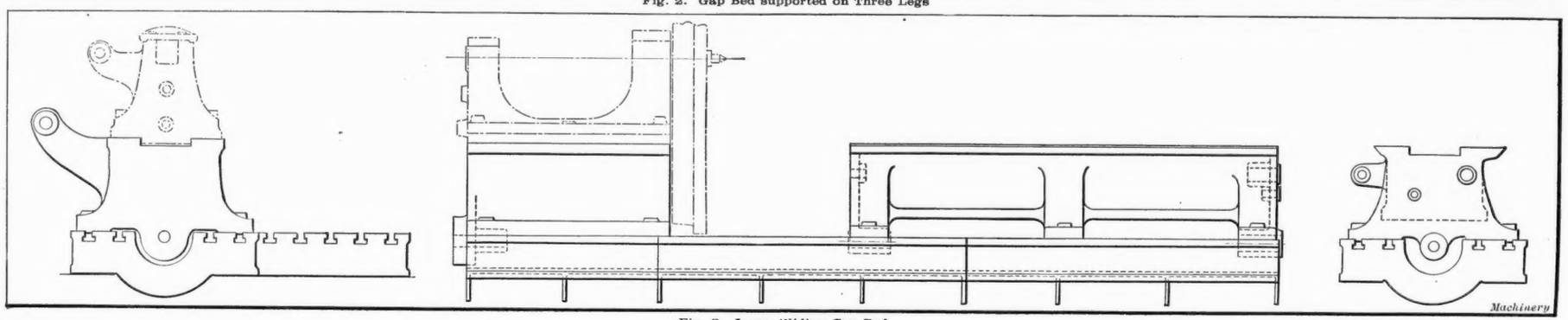

Fig. 3. Large Sliding Gap Bed

THE FORMS OF LATHE BEDS—3

THE LONGITUDINAL FORMS OF BEDS

By JOSEPH G. HORNER*

The remarks made in the previous installments relative to the flexure and torsion of lathe beds need not be repeated here, but we shall consider, with the aid of the representative illustrations, how flexure is best resisted, and how the longitudinal shapes are modified to serve different functions. The principal differences which are made in the forms of beds are those arising from variations in dimensions, while subsidiary differences are produced by special designs of lathes, or additional functions, or by the particular class of work which is done in the lathe. Thus, the shapes of beds of similar dimensions for ordinary screw-cutting or engine lathes and those for turret lathes are very often radically different. In the one case provision has to be included for the screw-cutting and feeding devices, for the carriage motions, and for the tailstock, while in many turret lathes these features are absent, and the bed is plainer, with provision only for clamping the turret base and the cross-slide. On the other hand, the arrangements for lubricating the cutting tools and work often introduce complications into the design of turret lathe beds, and the casting is of a more elaborate character below the bed proper—around the top of the legs or standards.

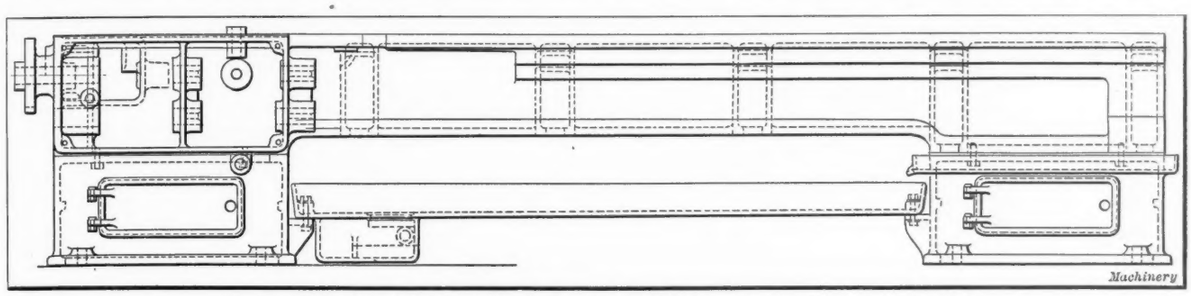

Fig. 4. Bed for 20-inch High-speed Lathe built by Smith & Coventry, Ltd., Manchester, England

The length of a bed has an important influence upon its construction and the number of supporting points, and if a gap is included, this also modifies the form to a considerable degree. The number of supports ranges from the single cabinet standard in some small lathes, and the two standards or legs in those of ordinary dimensions, to the three or more supports in longer beds. A continuous bed of full depth for the whole length is employed in lathes for heavy work and large swing, and is supported solidly on concrete foundations. The truth and rigidity of a lathe bed depends to a certain extent upon how it is fastened down. Ordinarily, beds are bolted rigidly to their foundation, which may be a wooden floor or a stone or concrete base.

Many years ago Prof. Sweet suggested the adoption of a tripod support for lathe beds, and this suggestion has been acted upon in practice. One end of the lathe is bolted down by the usual means, and the other is pivoted on a pin which passes through lugs in the bed and in the leg. The only support at that end is the pin on which the leg is free to adjust itself. Many firms also adopt the three-point support principle without any pivoting device: sometimes there are three points of contact with the foundation, and sometimes the bed is united to the legs at three points. The effect of an untrue foundation is thereby neutralized. Another method of affording good support is that of casting the bed with, or bolting it to, a single column of box form, which makes the lathe self-contained, and obviates any risk of distortion or winding. This construction is employed both for small ordinary lathes, and for turret lathes up to fairly large dimensions.

Legs or Supports for Lathe Beds

When legs are used to support the bed, it is the custom of some makers to spread the legs under the head to a greater extent than those under the right-hand end, to resist the vibration, which is more pronounced at the headstock end. Other firms do not put ordinary ribbed legs at all under the headstock, but prefer a boxed cabinet support, even when there are legs at the other end. The principle of this seems faulty, since, if it is considered necessary to put a box support under the headstock end, the use of a flimsy support at the other end of a heavy bed appears unreasonable. Many makers view the matter in this light, and place the bed on equally solid and substantial supports at both ends; sometimes the supports are of identical pattern, but frequently they are a little larger at the headstock end, in order to afford more cupboard room for tools and appliances.

The practice of placing the supports a certain distance inward from the ends, mentioned in a previous installment, is followed in many instances, and a further development of this principle is found in the case of some lathes, particularly those with gaps, where the metal of the boxed bed is carried down to a considerable depth under the headstock, gradually tapering off towards the ends. A great many turret lathes have their supports placed some distance inward from the ends of the bed, and the under side of the latter is often tapered or curved upward from the outside of the legs to the ends of the bed.

Gap Lathes

The question of forming a gap in a lathe bed has long been the subject of controversy. A gap lathe bed is practically as common in England as a straight bed. Theoretical considerations have been urged against it, chiefly on the ground that the bed is weakened, because its continuity is broken; but an English lathe maker would argue that the metal which is removed can be more than compensated for by extra metal placed underneath and beyond the gap, and in the heavier lathes by metal brought down to the ground in the form of a broad foot. The real objection to a gap is its unalterable dimensions—it is wider than is required for some jobs, and not wide enough for others. The fitting of the bridge-piece is also liable to become slightly inaccurate when a lathe has done much service, but this can be rectified.

The gap is nevertheless a great favorite because of the gen-

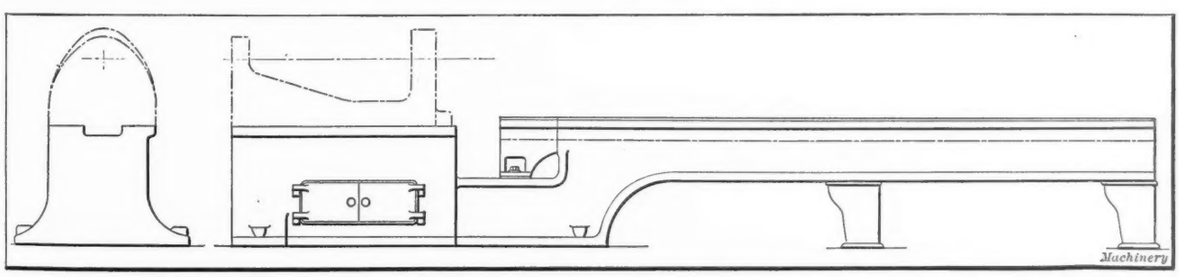

Fig. 5. Gap Bed with Support under the Gap

* Address: 45 Sydney Buildings, Bath, England.

eral and miscellaneous character of the work which has to be handled in most shops. Thirty or forty years ago such lathes predominated over all others, but gradually, with the growth in specialization, they have been displaced, to some extent, by straight-bed lathes on the one hand, and by regular facing lathes, and vertical turning and boring mills, on the other. Nevertheless, the rigid gap bed retains an important place in nearly all English shops, and is likely to do so because of its adaptability to so many varied classes of work. Usually, the makers now supply identically the same lathe with and without the gap. In some designs a sort of compromise is made, in that the metal immediately in front of the headstock is recessed to a moderate depth and width, leaving a gap which very considerably increases the usefulness of the lathe, but no gap-piece is required. The metal removed at the recess is compensated for by carrying the bed down deeper underneath, or by casting it with a continuous foot extending from the end of the bed to a certain distance beyond the gap.

The movable-gap is used to a moderate extent, in medium and large sizes of lathes, and would be adopted more extensively but for the fact of the ever-growing specialization. The breadth of gap is adjustable within a wide range, or it may be closed up entirely, the object being, of course, to support the carriage as close as practicable to the cutting point of the tool under all conditions. The most serious defect in gap lathes, perhaps, is the fact that the lead-screw has to be kept low down to be out of the way. In the movable-gap lathes another difficulty arises in the driving of the lead-screw, which has to be done from gears at the right-hand end of the bed.

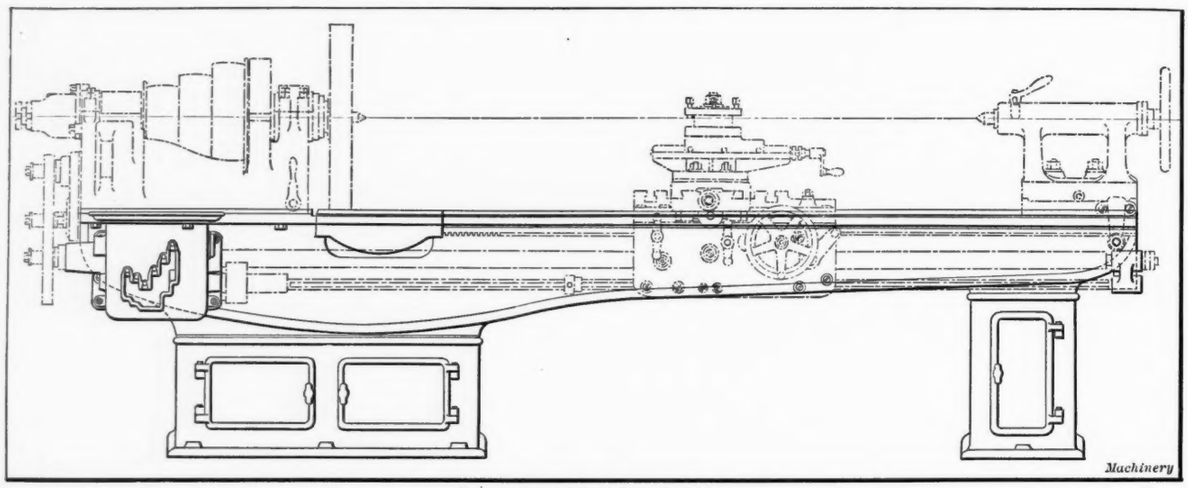

Fig. 6. Gap Bed of French Design

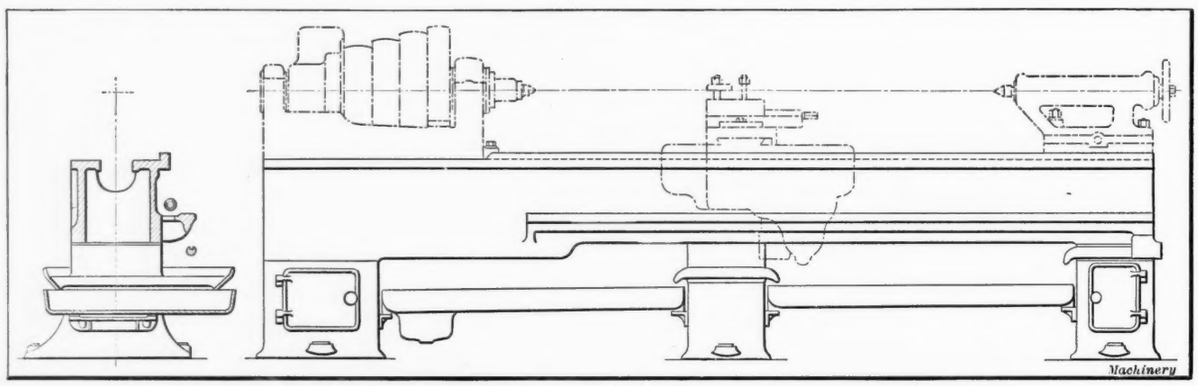

Fig. 7. High-speed Lathe Bed with Three Supports, as built by Darling & Sellers, Ltd., Keighley, England

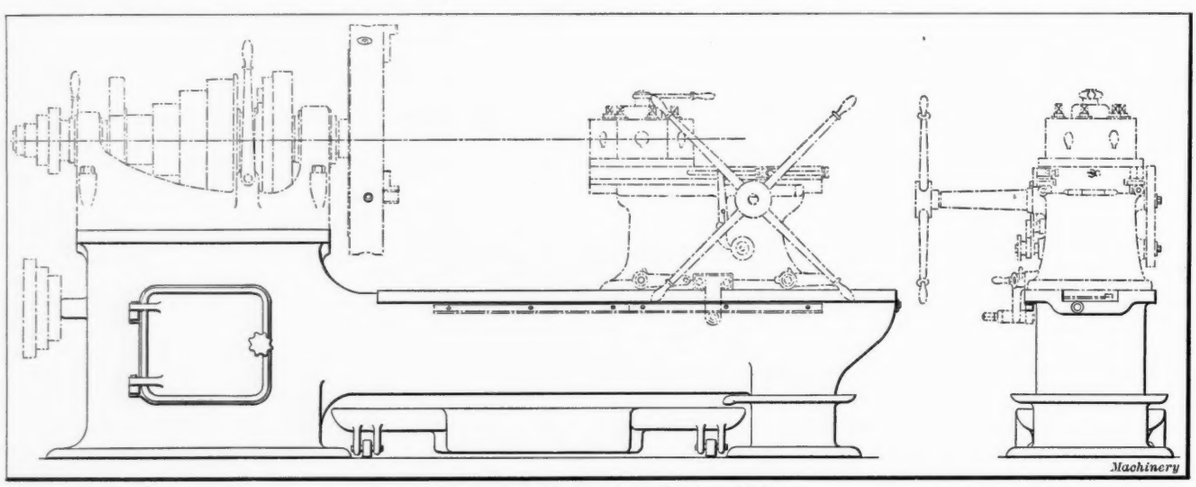

Fig. 8. Type of Bed used for Chucking Lathe

Types of Lathe Beds

The first illustration, Fig. 1, shows the form of a good type

of bed, supported on box standards at both ends. The bed is equipped for the use of cutting lubricant or oil, though not in such a perfect manner as some beds shown later. A more

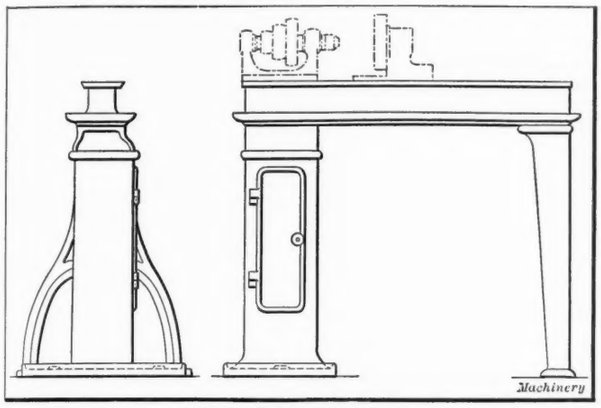

Fig. 9. Bed for Small Lathe

elaborate type of bed for a 20-inch high-speed lathe, built by Smith & Coventry, Ltd., of Manchester, England, is shown in Fig. 4. The cross-sectional shape of this bed was shown in a previous installment of this article. The details of the boxing and cross-ribbing and the joining of the bed to its standards will be observed. The right-hand standard is surrounded by an oil rim which conducts the lubricant into the trough, and at the top of the bed, close to the headstock, a space is left for the oil and chips to drop down into the trough.

The two principal designs of gap lathes are represented in Figs. 2 and 5, the first having the gap compensated for by the usual deepening underneath, and the other having a continuous base, such as is adopted for heavier lathes. In each case an intermediate leg is located under the bed, owing to its length. It will be noticed that in one case the gap-piece entirely fills the opening, while in the other it only partially does so, leaving a space for a large face-plate or chuck to remain in place, and still providing sufficient length for the support of the saddle.

Fig. 6 shows a French design of gap bed in which the metal is carried down in a graceful curve under the gap. The bed is well supported at this point on the wide cabinet base. An example of a straight bed supported on three equidistant bases is shown in Fig. 7, this being the bed of a Darling & Sellers' lathe, the section of the bed and saddle for which was shown in a previous installment. It will be noted, from the elevation, how the lower tier or guide rail would support the carriage if a gap were used. A design of bed for a chucking lathe is illustrated in Fig. 8; this is of the box type, with ample support underneath the headstock.

Two designs of beds which embody the same idea, with different proportions, are shown in Figs. 9 and 10, the first being for a small lathe, and the second for a larger one. A cabinet leg is used under the headstock end in each case. For beds of the proportions shown in Fig. 9 it is not generally the practice to use a cabinet base, but regular ribbed legs at both ends are used instead.

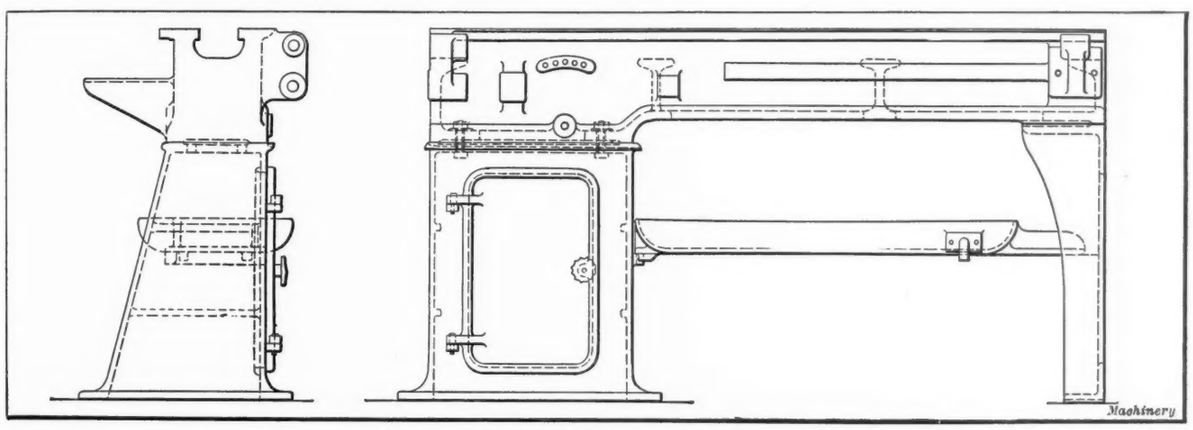

Fig. 10. Bed with Wide Cabinet Standard at One End

The arrangements for lubrication of the cutting tool and work, as mentioned before, affect the extent to which the bed is provided with oil-catching devices. The most complete method, short of placing the entire bed in a tray, is that represented in Fig. 11, with each base surrounded with an oil rim, leading into the trough between them. This arrangement does not provide for splashing, unless a sloping guard is fitted in front, or in both front and rear. A step further, as shown in Fig. 14, consists in fitting a single tray large enough

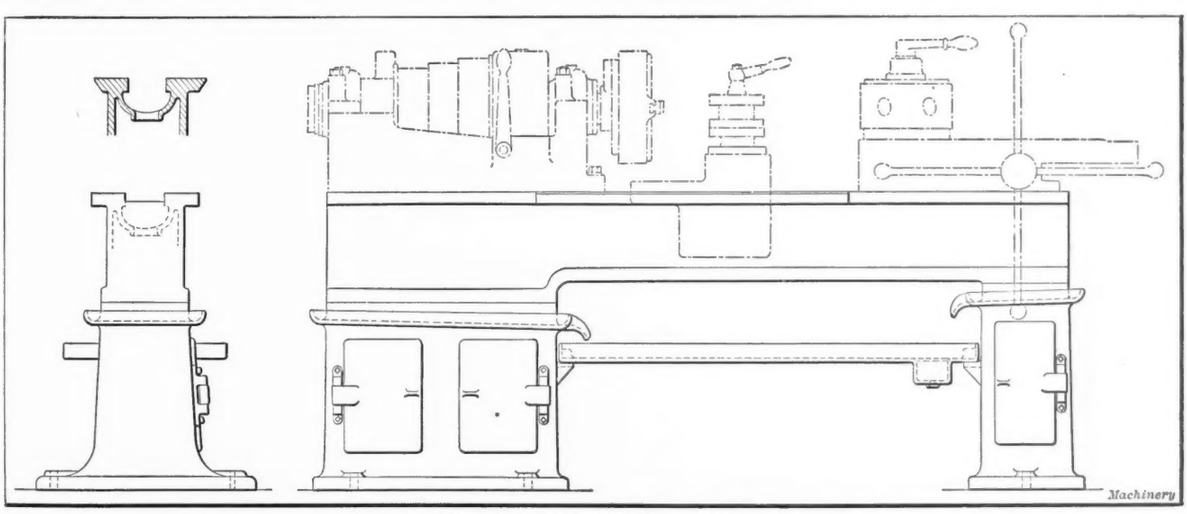

Fig. 11. Bed with Two Cabinet Standards of Unequal Size

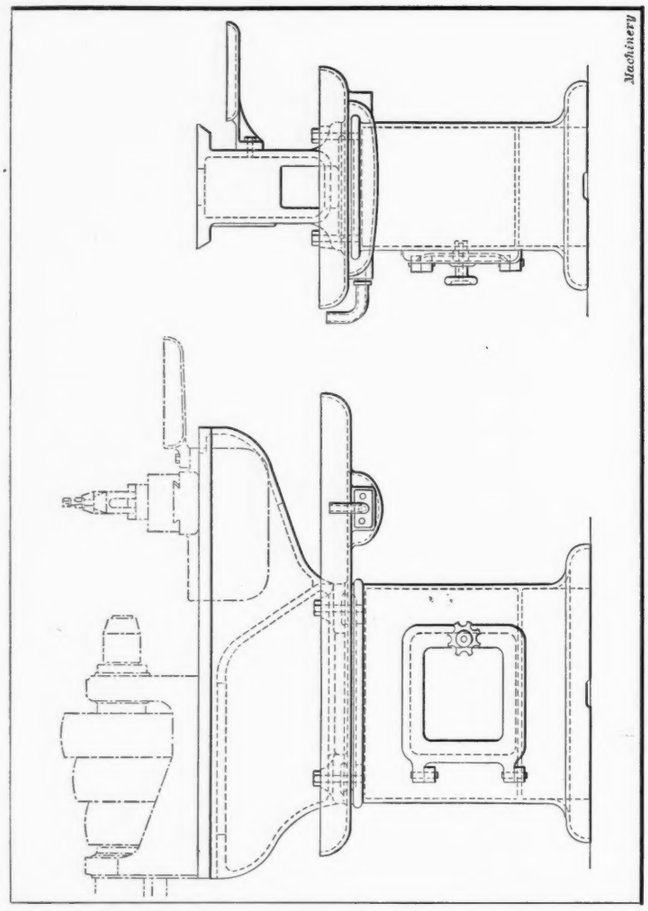

Fig. 13. Bed for Shaving Lathe with Single Cabinet Standard

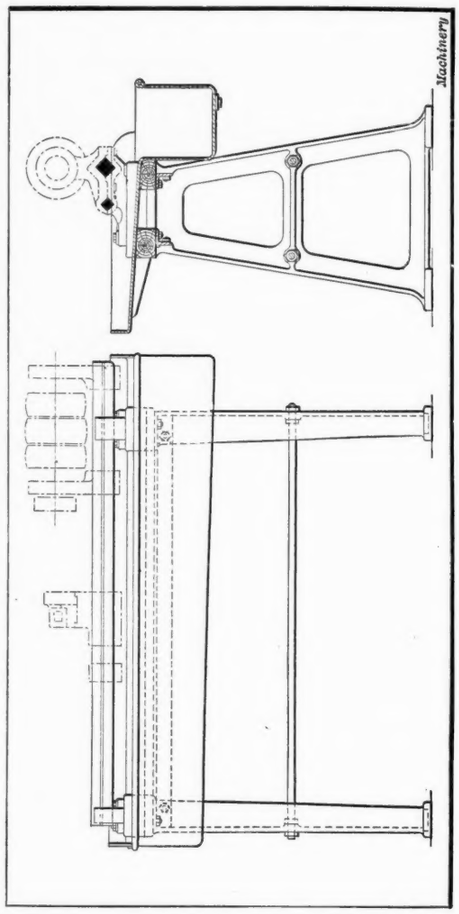

Fig. 15. Double-bar Type of Lathe as built by Brenot, Buronfosse & Cie., Paris, France

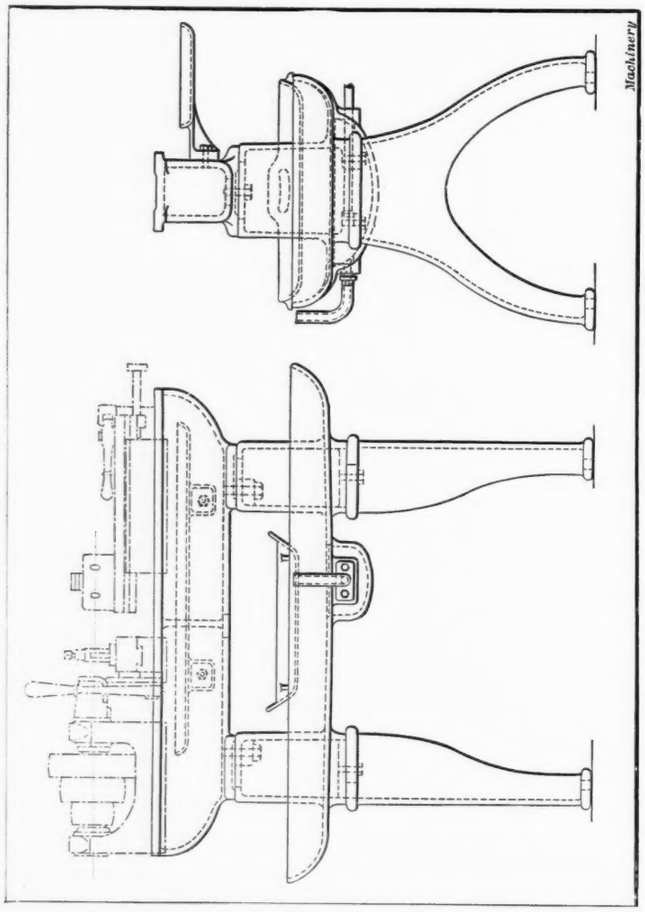

Fig. 12. Bed for Turret Lathe, showing Complete Cutting-tool Lubrication Arrangement

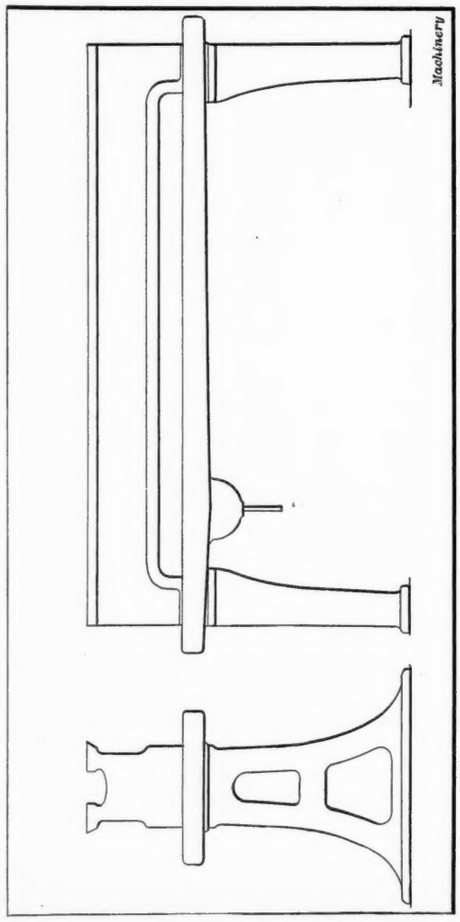

Fig. 14. Light Lathe Bed with Plain Leg Supports and Oil Tray

to extend around the entire bed. A more elaborate design is illustrated in Fig. 12, in which the tray is of ample capacity. An addition is sometimes made in the shape of sloping guards

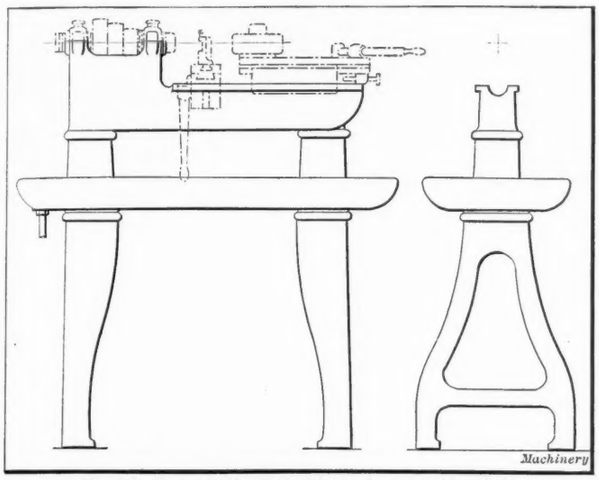

Fig. 16. Turret Lathe Bed with Head cast Solid with it

or oil catchers hung on the rim, not only at the front and the rear, but also at the ends. Single-standard beds, Fig. 13, are fitted in the manner shown, and for lathes of a size suitable for this design, are admirably adapted as regards steadiness and convenience.

The practice of casting the headstock in one piece with the bed is becoming more and more common both in ordinary lathes and in those of the turret type. It is not always cheaper than to make the head separately and bolt it on, but it may be so if quantities of similar beds are cast. In this case the machining will be cheaper also, provided there are proper facilities for dealing with the work. The principal idea, however is to gain greater rigidity and strength and consequent freedom from vibration. By carrying the webs up between the two bearings, as in Fig. 16, the two bearings are firmly tied together. This design is adopted largely in high-speed lathes with all-geared heads, the webbing extending up from the bed to form the lower half of the gear guards. There is then an opportunity of coring out a cavity large enough to receive big cone pulleys or gears, which could not be done if the head were made separately.

As a contrast to the foregoing examples, Fig. 15 seems like a reversion to primitive construction; this is the Brenot, Buronfosse & Cie screw-making lathe, with the two steel bars for a bed, illustrated in a previous installment. These bars are clamped in brackets at both ends; the brackets are supported on wooden bearers resting on A-shaped legs, tied together with distance bolts. The tray and tank are of galvanized plate.

A neat design of bed and head for a small lathe is shown in Fig. 17, cast with the tray for tools around it. Fig. 18 shows the bed used in some of the German Pittler turret lathes which are supported on a single box base arranged as shown with a strainer and trough for the lubricant and a receptacle for tools, etc. The cross-sectional view shows the jointing of the bed on the standard, and the section of the ways, which carry the turret saddle on vees. The dotted circle indicates the diameter of the vertical turret.

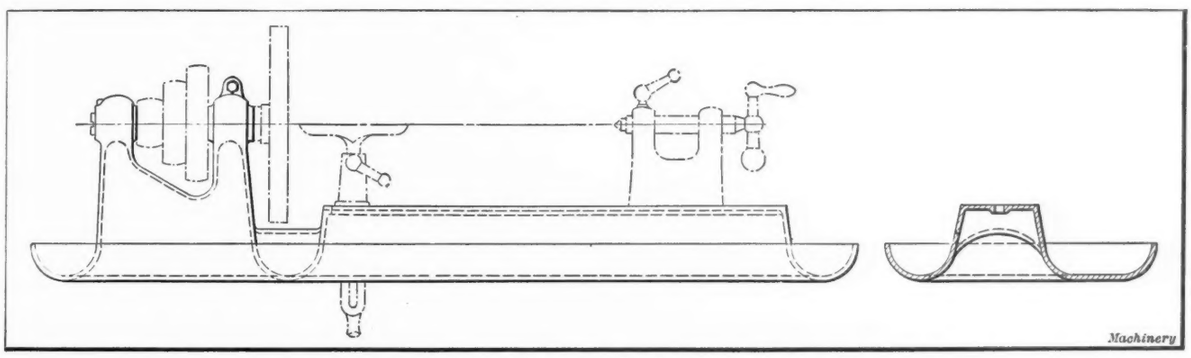

Fig. 17. Bed for Small Lathe with Head and Oil Pan cast Solid with it

Beds for lathes of large size embody the general principles which have been stated, but they are subject to a number of modifications which are not met with in those of medium and small size. Supporting legs are necessarily absent, the under side of the bed resting on its foundations for its whole length. Joints in the longitudinal direction as well as in the cross direction become necessary on account of convenience in casting, machining or transportation. Gaps or pits are

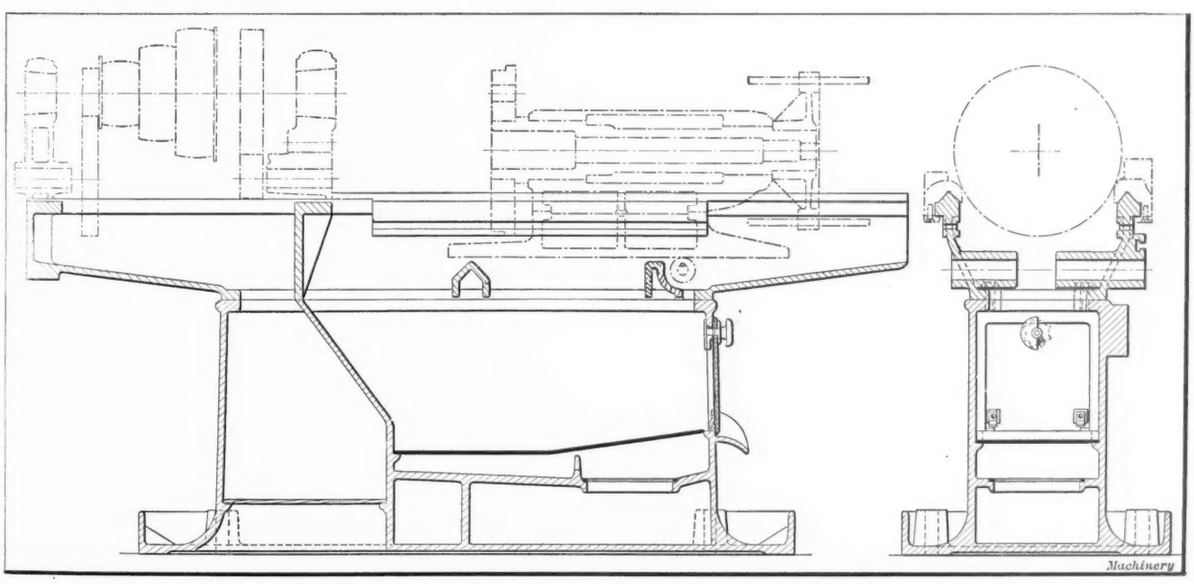

Fig. 18. Bed for the Pittler Turret Lathe as built by the Leipziger Werkzeug-maschinenfabrik, Leipzig-Wahren, Germany

used for lathes required for swinging large diameters, and sometimes the head is independent of the bed, except that it is mounted on the same foundation, that is, the cast-iron bed is not continuous. In some facing lathes the bed does not extend in the longitudinal direction, but comprises merely a support for the slide-rest. The slide movements are obtained only from the rests, and not from the bed. Sometimes the

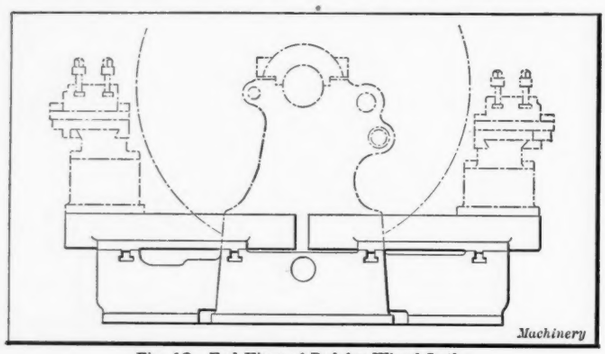

Fig. 19. End View of Bed for Wheel Lathe

longitudinal extension of the bed from the headstock carries only a tailstock or a boring head, and the rests are supported on wings extending toward front and back. In the sliding-gap lathes there is a pillar or pillars on the wings extending out from the front of the gap to carry rests, in addition to the regular saddle on the slide bed.

Figs. 19 and 20 show a bed for a wheel turning and boring lathe which has supplementary extensions to receive the four

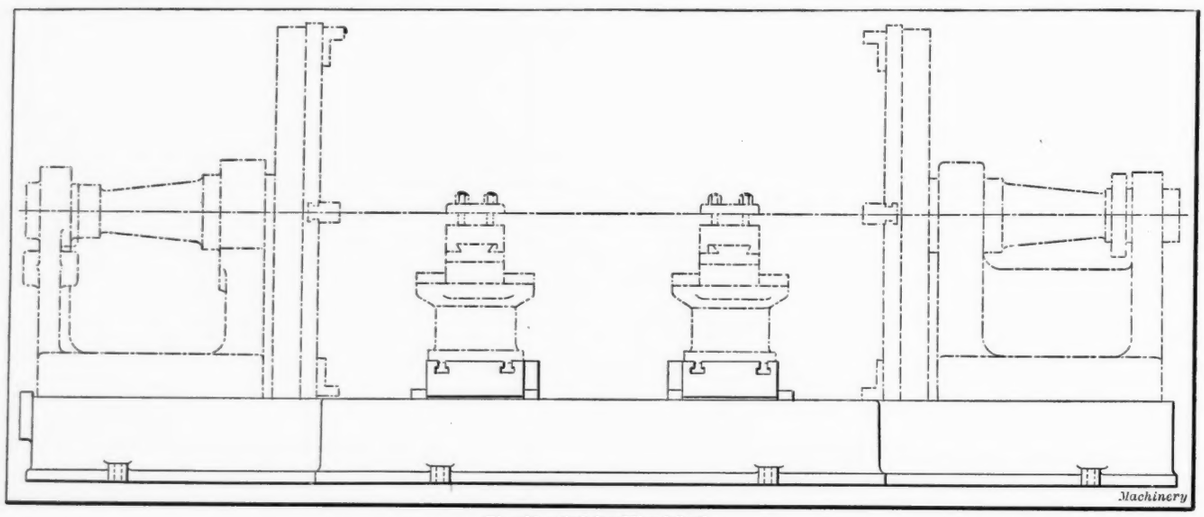

Fig. 20. Bed for Wheel Lathe

slide beds that carry the saddles. These beds are adjusted independently on the main bed; this is typical of a great many beds for different kinds of lathes.

Fig. 3 illustrates a built-up bed, with curved ribbing underneath, and a slide bed for carrying the tailstock and the saddle. The extension plate at the front carries the saddle of the rest for turning large work.

* * *

The laws passed by the legislatures of several states prohibiting the use of common drinking cups have created a large demand for collapsible and other forms of individual cups. Paper cups coated with paraffine are dispensed by automatic vending machines, the common cost being one cent each. But in many places it is not feasible to charge, although necessary to provide the sanitary cups. In order to provide for free distribution the cups must be made very cheaply. Automatic machinery has been developed which forms cups from paper disks, crimping the sides and forming a curved edge and coating them with paraffine at the rate of sixty a minute. The cups are packed automatically in cartons and human hands do not touch them at any stage of the manufacture. These cups are sold in sealed boxes containing ten for family use, at five cents. They are sold much cheaper in quantities to theaters, hotels, clubs, hospitals, etc.

ACTUAL AND CONSTRUCTIVE PATENT INFRINGEMENT—1

By E. D. SEWALL*

When entering upon the investigation of a subject at a point in its advanced development, there is a chance that one may reach erroneous conclusions by overlooking some fundamentals amid the intricacies of detail. It is well, therefore, to revert to the primer of patent law in seeking to discover what infringement of a patent is.

The Constitution authorizes Congress to secure for limited times to inventors the exclusive right to their discoveries. As ideas are not susceptible of exclusion from the apprehension of men who chance to perceive them, and as notions of natural justice do not admit of restraining the individual from putting the ideas he receives to innocent use, the exclusive right to a discovery can be secured only by affording inventors the aid of the public force to restrain all others over whom its authority extends from making practical use of the inventor's ideas.

This provision of the Constitution, Congress has sought to carry into effect by enacting that the patent right shall be conferred upon any person who has invented or discovered any new and useful art, machine, manufacture or composition of matter, under certain conditions, among others that he shall disclose clearly in writing the nature of his invention, and shall particularly point out and distinctly claim the part, improvement or combination which he claims as his invention or discovery; thereupon the government shall grant to him this right by an instrument under seal known as letters patent, for the term of seventeen years. (Sections 4886 and 4888, U. S. R. S.) This right, which does not exist except as created by statute, having been granted, becomes personal property, like other incorporeal chattels, except that, not being a common law right, it is not enforceable at common law, but only by enactment of the power that created it. Therefore, violations of the patent right, Congress has enacted, shall be remedied in the District Courts of the United States in the first instance, with appeal to the Circuit Courts of Appeal, and, in certain eventualities, in the Supreme Court of the United States, on *certiorari*. Damages for the infringement of any patent may be recovered by action on the case in the name of the owner of the patent; or injunctions may be had according to the course and principles of courts of equity, to prevent the violation of any right secured by a patent.

Nature of Patent Rights

The right secured by a patent, then, is an incorporeal right—a right of action in the U. S. courts to restrain others from making profitable use of the invention without the owner's consent, or for recovering damages for unauthorized use. It extends no further. All other rights in the property that may result from the invention remain to be adjudicated in the same manner as if this right created by Congress did not exist.

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Of the nature of a patent right, the Supreme Court of the United States has thus spoken:

"Whenever this court has had occasion to speak, it has decided that an inventor receives from a patent the right to exclude others from its use for the time prescribed in the statute." (Marshall, C. J., Grant vs. Raymond, 6 Peters, 243.)

"The franchise which the patent grants consists altogether in the right to exclude every one from making, using or vending the thing patented, without the permission of the patentee. This is all he obtains from the patent." (Taney, C. J., Bloomer vs. McQuewan, 14 How., 539.)

"The right to sell [the patented manufacture] was not derived from the letters patent, but it existed and could have been exercised before they were issued, unless it was prohibited by valid local legislation. All which they primarily secure is the exclusive right in the discovery. That is an incorporeal right, or in the language of Lord Mansfield 'a property in a notion having no corporeal tangible existence.'" (Harlan, J., Patterson vs. Kentucky, 97 U. S., 501.)

"Congress by its legislation made in pursuance of the Constitution has guaranteed to him [the patentee] an exclusive right to it [the invention] for a limited term; and the purpose of the patent is to protect him in this monopoly, not to give him a use which save for the patent he did not have before, but only to separate to him an exclusive use." (Brewer, J., U. S. vs. Bell Telephone Co., 167 U. S., 224.)

Thus Mr. Justice Miller before elevation to the Supreme Court:

"It is to be observed that no constitutional or statutory provision of the United States was or ever has been necessary to the right of any person to make an invention, discovery, or machine, or to use it when made, or to sell it to some one else. Such right has always existed and would exist now if all patent laws were repealed. It is a right which may be called a natural right, and which so far as it may be regulated by law belongs to ordinary municipal legislation, and it is unaffected by anything in the Constitution or patent laws of the United States." (*In re* Brosnahan, 18 Fed. Rep., 62.)

Proper Tribunals for Cases Involving Patented Articles

Remedies for wrongs against patented property, then, may be had by the same procedure and in the same tribunals as remedies for wrongs against unpatented property; but wrongs against the "property in the notion," the right of exclusion, which is an artificial right created by Congress, may be remedied only in the way and by the tribunals designated by Congress. When one patents an invention, he has all the rights and remedies respecting the invention that he had before, and when these rights are invaded his remedy is at common law or equity; but when the government grants the patent, it undertakes, figuratively, to police the industrial territory reserved to him, by preventing others from making, selling and using the patented product without his consent. If no one else attempts to make, use or sell the patented product, the benefits derived from the invention are not augmented by reason of the patent, and wrongs to the property of the inventor may be redressed by the ordinary machinery of the law; but when others seek without authority to make, use and sell that product, thus encroaching upon the reserved territory, the government steps forward and, as it were, ejects them.

A patent right is inconsistent with the natural rights of individuals. It often denies to others the common right of utilizing the products of their independent inventions. Hence, as the patent law confers a privilege that is in derogation of natural right, it should be invoked only to enforce the right that it creates, namely, to restrain others from making, using, and vending without the patentee's consent that which the claim of the patent defines as the thing patented. "The taking away of rights is not favored by the law. Therefore, statutes in derogation of common right are in the construction kept within their express provisions." (Bishop on Written Laws, Sec. 19.)

There is therefore a distinct kind of property in the patent right, injuries to which will be remedied by the U. S. courts in a patent suit; and another distinct kind of property in the industrial process or product to which the patent right pertains, injuries to which will be remedied in the state or other courts wherein violations of rights relating to personal property generally are adjudicated. Each of these two kinds of property rights should be adjudicated in the particular tribunals provided and under the particular laws relating to them respectively, lest there be danger of confusing the two rights, and a failure of justice by reason of the application, to one right, of the law that was designed to have application solely to the other.

Infringement of Patents

Infringement, generally, is a violation of a legal right. Infringement, in the language of the patent law, is a violation of the patent right only, and the term is not appropriate, in speaking of patents, to an invasion of those rights which the patentee has aside from the patent. The only persons whose rights can be infringed under the patent law are the owners of the whole or a part of the patent; they are the patentees, and no one else may bring an action for infringement. The owner may be the inventor, or one or more persons to whom he has assigned the patent. A purchaser or lessee of a patented article, or one who has a permission to make, use and vend the patented thing, owns no interest in the patent, and has no power to sue for infringement.

Infringement of a patent right consists usually in making the thing patented without the consent of the patentee, and in selling or using a thing so made, or in so using a patented process. The thing patented is that which is defined in the claims. The claims measure the invention. "As the inventor is required to enumerate the elements of his claim, no one is an infringer unless he uses all the elements." (Cimriotti Unhairing Co. vs. American Fur Co., Day, J., 198 U. S., 399.) If one makes, uses or vends without permission the exact combination claimed in a valid patent, he infringes the patent; also, if without authority he makes, uses or vends that which contains as a part thereof the exact combination claimed; but if he takes only a part of that combination, he is not an infringer.

Contributory Infringement

There is, however, a wrong to patentees known in the patent law as contributory infringement. Prior to 1896 the text books and legal precedents taught that contributory infringement consisted in conspiring with another, or abetting or wilfully aiding another, to make, use or vend an instrument, or to use a process defined in the claims of a valid patent without permission from the patentee.

"An infringement of a patent is a tort analogous to trespass or trespass on the case. From the earliest times all who take part in a trespass either by actual participation therein or by aiding and abetting it, have been held to be jointly and severally liable for the injury inflicted. There must be some sort of concert of action between him who does the injury and him who is charged with aiding and abetting, before the latter can be held liable. When that is present, however, the joint liability of both the principal and the accomplice has been invariably enforced." (Thomson-Houston Co. *vs.* Ohio, 80 F. R., 712, Taft, J.)

Necessarily, an act of contributory infringement presupposes an act of principal infringement by another. One may become liable for contributory infringement by assisting in constructing or renewing a patented combination, by furnishing to one who has no authority from the patentee some of the necessary parts with intent that they shall form a part of the infringing thing. These parts may be common, unpatentable things of general utility, or they may have no known use except in the patented combination. If the parts are of general utility, the person furnishing them must be proven to have had knowledge that they were to be used in constructing the patented thing, otherwise he is no infringer. (Snyder *vs.* Bunnell, 29 F. R., 47; Bliss *vs.* Merrill, 33 F. R., 39.) If they have no use except in the patented combination, the infringing purpose of the person furnishing them will be presumed, and he will be deemed a contributory infringer without other proof. (Wallace *vs.* Holmes, 9 Blatch., 65; Thomson-Houston Co. *vs.* Ohio, *supra;* Alabastine Co. *vs.* Payne, 27 F. R., 559; Leeds & Catlin Co. *vs.* Victor Talking Machine Co., 213 U. S., 318, McKenna, J.)

The law of contributory infringement, in substantially the circumstances noted above, must be deemed to be settled, since the U. S. Supreme Court has upheld it in the talking machine case above cited, wherein defendant, charged with making non-patented record disks of a kind particularly adapted to be used as a part of a patented combination comprising the record disk and a reproducing stylus in defined relation thereto, was held to be a contributory infringer. In the opinion it was said:

"A combination is a composition of elements . . . It is, however, the combination that is the invention, and is as much a unit in contemplation of law as a single or non-composite instrument. Whoever uses it without permission is an infringer of it . . . It can make no difference as to the infringement or non-infringement of a combination that one of its elements or all of its elements are unpatented."

Complicated Questions of Contributory Infringement

Although the law as above set forth is believed to be just, yet nice discrimination is often required to avoid stretching the law to restrict the common right of freedom of trade. Shall not only he who purposely makes and supplies the record disk to be assembled by an infringer with the motor and stylus to make a patented instrument, be liable as a contributor to the infringing act, but also he who furnishes the raw materials with knowledge that they are to be used to make such record disks?

Not only may infringement by a principal infringer be aided by one supplying necessary parts of the patented thing, but also by one providing an instrument with the purpose that it shall be used in practising a patented process without the consent of the patentee. Thus where a filter was furnished with the intent that it should be used in carrying out a patented process of filtering beer without the patentee's consent, and it was so used, the one furnishing the filter was held liable for contributory infringement of the process. (Loew Filter Co. *vs.* German-American Filter Co., 107 F. R., 949.) In such a case it must affirmatively appear that the one furnishing the instrument was knowingly a direct accomplice of the principal infringer, and the question is to be decided upon the particular facts of the case, for it cannot be deemed settled that the seller of a common mechanic's tool is guilty of infringement because he knows it is to be used in aiding to practise a patented process.

Case of the Commercial Acetylene Co. vs. Autolux Co.

One may also become liable as a contributor by supplying to a principal infringer an instrument adapted to aid in making a patented article. Here also the liability of him who supplies the instrument depends upon proof of intent to aid the principal in invading the patent right; and the circumstances that the instrument is a common one of general utility, or on the other hand of utility only in the manufacture of the patented product, may have effect one way or another on the liability of him charged as an accomplice. In the case of Commercial Acetylene Co., *et al.*, *vs.* Autolux Co., 181 F. R., 387, the complainants were the owners of patents granted to Claude and Hess for a package containing acetylene gas. Among the claims of the patents is the following: "A gas package comprising a holder or tight vessel; a contained charge of acetone; a volume or body of gas dissolved by and compressed and contained within the solvent, and a reducing valve applied to an opening extending to the interior of the holder above the level of the solvent." The invention was one of great commercial value. It provided a solution of the problem of safely storing acetylene in large or small quantities in condition for use as desired. The patent was not for a special tank but for a package of gas held under pressure in solution. An exclusive license to make, use and sell this package in the United States had been accorded to the Prest-O-Lite Co.

According to the text of the decision, one of the original officers and stockholders of the Prest-O-Lite Co. severed his relation therewith for the purpose of establishing a plant for the manufacture of an infringing device, and also for recharging the tanks made by the Prest-O-Lite Co. when the gas had been consumed by the individual users. He was actively engaged in committing direct infringing acts until enjoined by an order of the court, on final hearing, from making the infringing device, which was known as the autogas tank, or committing any other infringing act. The party thus enjoined and his associates then organized a new corporation under the name of the Autolux Manufacturing Co. for the purpose of manufacturing an apparatus known as a high pressure generator, which, the court said, had been extensively used in recharging Prest-O-Lite gas packages and other gas tanks used on automobiles.

Now, the Claude and Hess patents contained claims for a receptacle containing gas dissolved in acetone. When the gas had been consumed the combination was destroyed, and whoever again assembled or conspired with another to assemble that combination without the patentee's consent made the patented article and infringed the patent. The receptacle alone was not patentable, but only the receptacle containing the gas in solution. The recharging of the package was as much a making of the patented article as would be the reconstructing of a patented sewing machine, which had been worn out, by taking the unpatentable table, drive wheel, and treadle, and assembling therewith new parts to make a new machine. Although the court made the statement that the generator supplied by defendants was extensively used in recharging Prest-O-Lite *and other gas tanks used on automobiles*, it must have satisfied itself that the maker of these generators intended them to be used in reconstructing Prest-O-Lite gas packages and was guilty as an accomplice of the person who actually procured the recharging of such tanks without the permission of the Prest-O-Lite Co., thus deriving profit by aiding others to do that which the patent reserved to the patentees and their assigns and licensees.

The fact, assumed to have been proven, that the defendant company actively and directly assisted others in reproducing a patented article, was one ground of the decision in the Prest-O-Lite case, and appears to be in accordance with the long established principles of contributory infringement. Another ground of the decision is based upon a more recent extension of the doctrine, to be referred to later.

Summary

It appears, therefore, to be settled that not only he who makes, uses and sells a patented thing without permission from the patentee infringes the patent and may be sued under the patent laws, but also he who actively and knowingly assists in the unauthorized making of a patented thing; and probably also that he who actively and knowingly assists another person in selling or using a patented thing that has come into the possession of that other person *against the permission of the patentee* may be likewise liable under the patent laws. The fact that not all acts that aid more or less directly or indirectly in infringement by another can be deemed to be acts of contributory infringement does not affect in any way the point under consideration, which is that such acts as invade the *patent right* only, raise any question under the patent law. If the allegations of fact are that the act complained of invades the monopoly—narrows the reserved market of the patentee by aiding in the unauthorized manufacture, sale and use of the thing patented, and which the patent reserved to him—the case made is one to be tried under the patent law, because the common law and laws of the states make no provision for property in a right to restrain others from making and dealing in useful commodities, but only the patent laws.

Thus far it has been sought to show, no doubt with some repetition, what right a patent confers, when it is infringed, and where the remedy for infringement lies. It has also been asserted that rights regarding patented property which do not bring into question the patent right to exclude others, have the same adequate remedies under general law as other property rights, and it has been intimated that the adjudication of the one kind of right in the courts provided for adjudicating the other, or the attempt so to do, may result in the inappropriate or inadequate remedy, or none at all.

The Questions to be Decided in a Patent Case

Very briefly may be discussed the tests that may be applied to determine whether an alleged injury to a patentee's rights is an infringement of the patent right. A charge of infringement of a patent puts in issue either (1) the title of the patentee; (2) the validity of the patent; or (3) the identity of the alleged infringing product or process with that claimed in the patent. One charged with infringement may defend by (1) denying the validity of the patent; (2) denying the title of the patentee; (3) denying the identity of the thing alleged to be made, sold or used by him with that defined in the claims of the patent. If, on the other hand, the alleged infringer concedes all these, but alleges an agreement with the patentee or his nominee whereby he was permitted to use the

patented thing, a question of contract is raised out of the violation of which the wrong to the patentee, if any there be, proceeds, and which the ordinary law of contract is adapted to remedy. (Wilson *vs.* Sanford, above; Dale Tile Co. *vs.* Hyatt, 125 U. S., 46, Gray, J.)

If one surreptitiously destroys a patented still, because he deems the manufacturer of alcoholic liquor immoral, he does not thereby deny the title of the patentee, the validity of the patent, nor the identity of the still destroyed with that which is patented. The wrong complained of raises a question for the ordinary criminal law to deal with. So, if the patentee of a butter substitute seeks to sell it in a state the laws of which make the sale of a butter substitute of that character a penal offense, the action of the state in preventing the sale thereof is not a denial of the title of the patentee, the validity of the patent, nor the identity of the substance sold with the patented substance, but is a criminal prosecution and one in which the validity of the laws of the state may be put in issue. (*In re* Brosnahan, above; Patterson *vs.* Kentucky, above; Webber *vs.* Virginia, 103 U. S., 344, Field, J.)

If a patentee makes a shipment of patented articles and they become damaged *en route* by the fault of the common carrier or his agents, no question of title, validity of the patent, or identity arises, the injury being a simple tort cognizable in the state courts, or in the federal courts solely on the ground of amount involved, diversity of citizenship, or interstate commerce. If a patentee of a useful article makes a contract with a manufacturer of an inferior article having a similar use, whereby the patentee agrees for a money consideration not to place his article on the market, or license others so to do within the state wherein the manufacturer of the inferior article is situated, no question affecting the validity, ownership or scope of the patent is raised, and the patent law has no dominating influence such as would prevent the courts of the state holding the contract to be one in restraint of trade, and imposing penalties accordingly. (Blount Mfg. Co., *vs.* Yale-Towne Mfg. Co., 166 F. R., 555.)

[The Supreme Court of the United States handed down a decision March 11 which apparently will have far-reaching consequences in furthering monopolistic control of patented apparatus by the makers. By a decision of four to three it was held that the maker of the Dick patented rotary mimeograph machine has the right to restrict the use of the machine to the supplies furnished by the maker. Chief Justice White in the dissenting opinion pointed out how dangerous the decision may be:

"My reluctance to dissent, is overcome in this case: First, because the ruling now made has a much wider scope than the mere parties to this record, since, in my opinion, the effect of the ruling is to destroy in a very large measure the judicial authority of the states by unwarrantedly extending the Federal judicial power.

"Second, because the result just stated, by the inevitable development of the principle announced, may not be confined to sporadic or isolated cases, but will be as broad as society itself, affecting a multitude of people and capable of operation upon every conceivable subject of human contract, interest, or activity, however intensely local or exclusively within state authority they otherwise might be.

"Third, because the gravity of these consequences which would ordinarily arise from such a result would be greatly aggravated by the ruling now made, since the ruling not only vastly extends the Federal judicial power as above stated, but as to all the innumerable subjects to which the ruling may be made to apply, makes it the duty of the courts of the United States to test the rights and obligations of the parties not by the general law of the land, in accord with the conformity act, but by the provisions of the patent law, even although the subject considered may not be within the embrace of that law, thus disregarding the state law, overthrowing, it may be, the settled public policy of the state and injuriously affecting a multitude of persons."

In view of the gravity of the decision which was made by four out of seven judges, whereas a full court consists of nine judges, the effort probably will be made to have a rehearing of the case before a full bench. It is generally conceded that the decision may lead to the creation of monopolies of the most oppressive sort.—EDITOR.]

* * *

To furnish good lockers is the duty of the institution—to take good care of them is the duty of the men using them.

BRASS ENGRAVING BY MACHINERY

By CHESTER L. LUCAS*

Among the many operations now being done by machinery instead of by hand, the engraving of brass signs and plates is of more than passing interest. The old way of making brass signs was to chip out the letters by hand, the quality of the work depending wholly upon the skill of the workman. Naturally the progress was very slow. At the present time many brass signs are etched, and a considerable number are cut by machinery. Another large field for brass engraving by machinery is in the making of printing plates for printing wooden box-sides. Not only has the introduction of engraving machinery resulted in faster work, but it has made it possible to do this work without the employment of skilled engravers.

Fig. 2 shows a Wesel routing machine in use at the Schwerdtle Stamp Co., in Bridgeport, Conn. The machine is shown at work on a brass sign, the work being more clearly

Fig. 1. Brass Dies for Bookbinders' Use and Cutters used for Engraving

shown in Fig. 3. The most essential features of a machine of this kind are that straight cuts can be quickly made either vertically or horizontally; that the cutter spindle rotates at a high speed without vibration; and that the cutter can be easily moved to any part of the work, there still being no play between the connecting joints. In this machine, a pulley on the vertical driving shaft transmits motion to the two-step cone pulley *A*. This pulley is mounted upon the swinging arm *B*, and its position is adjustable to allow for slight variations in belt lengths. From the adjustable slide *C* a second arm extends at right angles to arm *B;* this second arm is free to swing in the same plane as the first arm, and at its extreme end the cutter spindle is mounted.

The cutter spindle and adjacent parts are shown on a larger scale in Fig. 3. The cutter spindle (*D* in Fig. 3) receives its motion from the belt that passes over pulley *E*. This pulley is located at the center of the cutter spindle, thus equalizing the pull on the bearings. As the spindle revolves at the rate of 16,000 R. P. M., it is essential that the bearings should be good. The cutter *F*, or "bit," as it is called, is held in the end of the spindle. Just above it is a small aluminum fan *G* that blows the chips away from the cutter, leaving the lines to be followed in plain sight.

It will be noticed that the cutter spindle is mounted in a slide *H* that may be raised or lowered to accommodate thick or thin plates, or long or short cutters. This slide is operated by means of screw *I*. To supply artificial light, when needed, the two incandescent lights are provided; the use of two lights, on opposite sides of the cutter, eliminates

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the shadows. The cutter-head is supported by means of a bar *K*, resting upon a small grooved roll on rail *L*, Fig. 2. By means of hand-rod *M*, the cutter is moved to and from the operator to make the perpendicular lines of the letters, and by moving bar *K* along the rail, the horizontal cuts are made. A bracket that is hidden by pulley *A* guides the horizontal movements of the cutter. Handwheel *N* is tightened only when the routing machine is used as a radial arm machine, in which case cuts may be made in any direction.

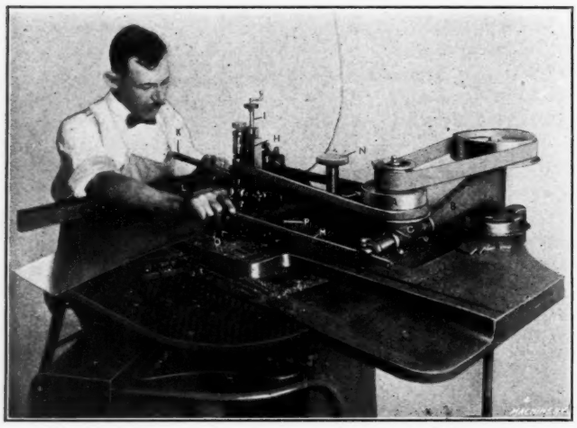


Fig. 2. Wesel Routing Machine at Work on a Brass Sign

The cutter-head is raised by a foot treadle when necessary to jump from one letter to another, and the machine is started and stopped by another foot treadle. The work is held in place by clamping jaws, one of which is shown at *O*. This jaw is movable, and is tightened against the edge of the plate by handwheel *P*.

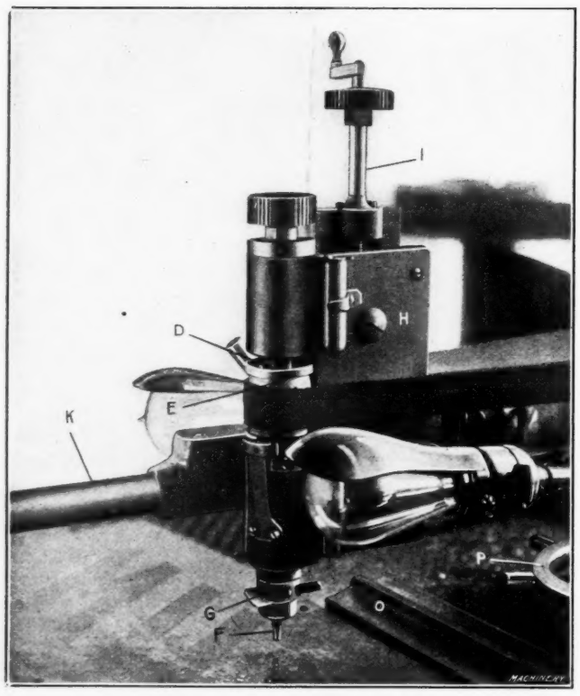


Fig. 3. Cutter-head at Close Range

The work of an engraving machine is not confined to large signs and plates, but is also utilized in getting out brass dies for bookbinders' use, similar to those shown in Fig. 1. It is impossible to finish completely such work as these dies on the machine, but the bulk of the metal in and around the design may be removed to good advantage. Some of the cutters used on this class of work are also shown in this illustration, most of them being of the one-lip variety, as this style of cutter is strong and has plenty of chip-room.

On work of this nature, the skilled engraver is still required to finish up the work, truing up the lines and cutting the parts that it is impossible to finish on the machine. Engravers' tools of various shapes are used for this part of the work. Fig. 4 shows an engraver, Mr. Louis F. Schwerdtle, finishing up brass dies. The work is held in a ball vise, made especially for engravers' use. Two jaws *B*, which swivel, are mounted upon the secondary jaws *C*. The jaws *B* contain numerous small holes in which pins may be placed to grip the work. These pins are usually shaped so as to grip the work without marring it. The secondary jaws *C* are located and held in place by large dowel pins upon the primary jaws *D*, which latter are operated by the right- and left-hand screw *E*, working in base *F*. It will be seen that this vise is doubly useful, for when not in use on small work, as shown, the vise may be utilized on large die work, by simply pulling off the secondary jaws *C*, which allows the primary jaws *D* to be used independently.

Fig. 4. Finish-engraving Small Dies*

* * *

BOILING POINT OF METALS

In a paper presented at a meeting of the Faraday Society, London, England, Mr. H. Greenwood gave the boiling point of various metals at atmospheric pressure, as follows:

	Degrees F.
Antimony	2625
Bismuth	2550
Copper	4200
Lead	2775
Magnesium	2050
Silver	3500
Tin	4125
Aluminum	3250
Chromium	4000
Iron	4450
Manganese	3450

* * *

ARMOR PLATE VS. PROJECTILES

The competition between increased thickness and quality of armor plate versus big guns has come to a point where it is very evident that the big gun is victorious. The armor carried by battleships of the Dreadnaught type cannot prevail against the latest guns carried by the same ships. The latest guns made by the British navy and used on the *Orion* and the *Lion* fire a 1250-pound projectile. When it is remembered that an 850-pound projectile will pierce 17 inches of the best Krupp steel, it is evident that only an excessively thick armor would insure a vessel against the attacks of these new heavy guns. It, therefore, seems likely that the man-of-war of the future will carry less heavy armor, protection being obtained instead by high speed. This idea, in fact, has been carried out in the British navy in the battle-cruiser *Lion*, in which high speed, heavy guns and light armament has been consistently adhered to throughout the design.

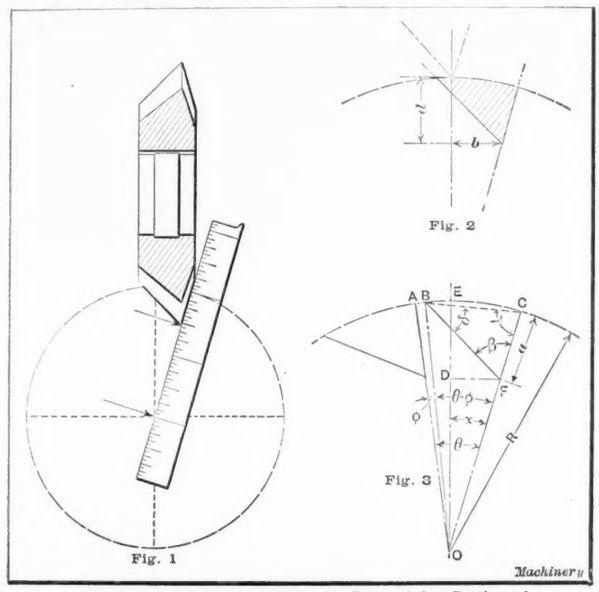
* For a complete description of the engraver's vise see MACHINERY, June, 1909, "Making an Engraving Block."

SETTING DOUBLE-ANGLE FLUTING CUTTERS*†

By GEORGE W. BURLEY‡

The ordinary method of setting double-angle milling cutters when fluting spiral mills and reamers is only an approximate one, and depends entirely upon the skill of the milling machine operator for its success. This method is indicated in Fig. 1. As will be seen from this illustration, two operations have to be performed simultaneously: the cutter has to be so arranged with respect to the center or axis of the blank that the edge of the scale or rule laid alongside the cutter, as shown, passes through the blank-axis, and that the distance from the center to the point of the cutter is a definite amount. This definite amount is a predetermined quantity, and is equal to the difference between the radius of the cutter or reamer to be fluted and the depth of the flute, which, of course, are elements in the design of the cutter or reamer.

It is fairly obvious that errors can readily be made; and it is not inconceivable that angular errors up to 1 degree and linear measurement errors up to 1-64 inch, or even greater, are being continually made. When this is the case, the finished cutters or reamers are not the same as those originally designed. By the method to be described in the following,



Figs. 1 to 3. Finding Formulas for Determining Setting of Double-angle Fluting Cutters

however, it is possible to set the fluting mill with respect to the cutter blank without recourse to the use of a rule, either for the purpose of making linear measurements or obtaining correct angularity. The method involves the setting of the cutter central (that is, with the angular point of the cutter exactly over the axis of the blank) and at a distance from the axis equal to the radius of the blank, as is indicated by the dotted lines in Fig. 2. This is done in the usual way. To get the off-set, the table is moved transversely an amount equal to b (Fig. 2), and raised an amount equal to d. These distances vary considerably, the exact values depending upon the radius of the blank, the number of flutes to be cut in it, the width of land, and the angles of the fluting cutter; but, whatever these distances are, they can be obtained on the machine directly from the micrometer dials on the feed-screws. The values of d and b for any particular case can be calculated in the manner indicated below, or taken directly from the accompanying Data Sheet Supplement.

Let R = the radius of the cutter to be fluted.
N = the number of teeth to be cut in it.
W = the width of the land of the tooth.
θ = the angle subtended at the center of the cutter by any one tooth.
a = the depth of each tooth measured radially.
α = the small side-angle.
β = the included or total angle of the angular fluting cutter.

R is the radius of the finished cutter, and as the blank is invariably left a little large, corrections, as will be indicated later, may have to be made for d, but not for b; usually, it will be found that the correction is a very slight one.

$\theta = \dfrac{360}{N} = A\,O\,C$ (Fig. 3); $E\,O\,C = \alpha$, and $B\,F\,C = \beta$.

The width of the tooth-land, as usually defined, is measured on the face formed at the back of the cutting edge by the grinding wheel, and it is, therefore, a straight-line quantity, whether the land is formed by a cup-wheel (forming a flat land) or a disk wheel (forming a concave land). This is, therefore, not exactly the quantity $A\,B$ (Fig. 3), measured as an arc of the circle, but the difference between the two is usually so slight as not to be worth consideration from a practical point of view. As a matter of fact, the writer has found that the difference in the most extreme cases amounts to only three or four thousandths inch, an amount which, under the circumstances, is negligible. Hence, in what follows, we shall assume that the actual width of the land and the arc AB are equal. Let the width of the land and, therefore, the length of the arc $A\,B$ be equal to W. Then angle ϕ is the angle subtended by arc W at the center of the circle, and can, therefore, be determined by first calculating the angle in radians or fractions of a radian, and then consulting a table of angles for the equivalent angle in degrees. If no such table is handy or immediately procurable, the angle in degrees can be obtained as follows:

$$\phi \text{ (in degrees)} = \frac{W}{R} \times 57.296 \qquad (1)$$

From this angle and the angle θ, the angle $(\theta - \phi)$ can be obtained. This angle is the one which is subtended at the center of the circle by the chord $B\,C$; therefore,

Angle $B\,C\,O = \gamma = \left(90 - \dfrac{\theta - \phi}{2}\right)$. The angle $C\,B\,O$ is also equal to this. Hence,

Angle $C\,B\,F = \delta = 180 - (\beta + \gamma) = 180 - \left(\beta + 90 - \dfrac{\theta - \phi}{2}\right)$

$= 90 - \left(\beta - \dfrac{\theta - \phi}{2}\right)$.

Let the length of the chord $B\,C = c\,R$, c being the length of the chord of a unit-radius circle which subtends the angle $(\theta - \phi)$ at the center. Then,

$$\frac{c\,R}{\sin\beta} = \frac{a}{\sin\delta}; \text{ therefore,}$$

$$a = \frac{c\,R \sin\delta}{\sin\beta} = \frac{c\,R \sin\left(90 - \beta + \dfrac{\theta - \phi}{2}\right)}{\sin\beta}$$

$$= \frac{c\,R \cos\left(\beta - \dfrac{\theta - \phi}{2}\right)}{\sin\beta} \qquad (2)$$

From this expression, assuming any given data, the actual depth a of the flutes to be milled in the cutter blank can be calculated.

$$O\,F = (R - a)$$

$$= R - \frac{c\,R \cos\left(\beta - \dfrac{\theta - \phi}{2}\right)}{\sin\beta} = R\left\{1 - \frac{c \cos\left(\beta - \dfrac{\theta - \phi}{2}\right)}{\sin\beta}\right\}$$

Now, d (Fig. 2) $= E\,D$ (Fig. 3) $= R - O\,D = R - O\,F \cos\alpha$

$$= R - R\left\{1 - \frac{c \cos\left(\beta - \dfrac{\theta - \phi}{2}\right)}{\sin\beta}\right\} \cos\alpha \qquad (3)$$

Usually the radius of the cutter or reamer blank is made a

* With Data Sheet Supplement.
† For information on allied subjects, see "Milling Axial Teeth in Cutter and Reamer Blanks," March, 1912, and articles there referred to.
‡ Address: University of Sheffield, Sheffield, England.

little larger (a few thousandths inch) than the finished cutter. Therefore, in actual practice,

$$d = R_1 - R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \qquad (4)$$

where R_1 = the radius of the blank.

For any given values of $\frac{W}{R}$, N, α and β, the expression:

$$\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\cos\alpha \text{ is a constant.}$$

Let this constant be represented by x; then,

$$d = R_1 - x\,R. \qquad (5)$$

This is the "elevation" formula, the values of x for a large number of combinations of $\frac{W}{R}$, N, α, and β, occurring in practice being given in the tables in the accompanying Data Sheet. The values of x for any combination not included in the tables can be determined as indicated above, or obtained by interpolation.

Further, b (Fig. 2) = $D\,F$ (Fig. 3) = the cross-movement required = $O\,F\sin\alpha = (R - a)\sin\alpha =$

$$R\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\sin\alpha \qquad (6)$$

Again, for any given combination of $\frac{W}{R}$, N, α, and β, the expression:

$$\left\{1 - \frac{c\cos\left(\beta - \frac{\theta-\phi}{2}\right)}{\sin\beta}\right\}\sin\alpha \text{ is a constant.}$$

Let it be called y. Then $b = y\,R$. (7)

This is the "cross-movement" formula, the values of y for a large number of combinations being given in the accompanying Data Sheet beside those of x for the same combinations.

In regard to the values of $\frac{W}{R}$ which have been selected, the lower values are those usually chosen for milling cutters of medium and large sizes, the higher values being usually chosen for small cutters and reamers. If the value adopted in any particular design is not found in the tables, a simple calculation is all that is necessary for the determination of the corresponding values of x and y. By way of an illustration, let us suppose that 0.030 has been adopted as the value of $\frac{W}{R}$, and that $N = 20$ teeth, $\alpha = 12$ degrees, and $\beta = 60$ degrees. Then, upon consulting the accompanying tables, we find that when $W \div R = 0.020$, $x = 0.7750$, and $y = 0.1643$, and that when $W \div R = 0.040$, $x = 0.7908$, and $y = 0.1677$. By simple proportion, which in this case is sufficiently accurate, when $W \div R = 0.030$, $x = 0.7829$, and $y = 0.1660$. Therefore for the combination chosen,

$$d = R_1 - 0.7829\,R \text{ and } b = 0.1660\,R.$$

Dealing further with this case, let us assume that $R = 2.5$ inches, and that $R_1 = 2.503$ inches. Then,

$d = 2.503 - (0.7829 \times 2.5) = 2.503 - 1.9572 = 0.5458$ inch, and $b = 2.5 \times 0.1660 = 0.4150$ inch.

If this method of interpolating is not deemed sufficiently accurate, then the values of θ, ϕ, α, β and c can be determined for any particular case and introduced into Formulas (4) and (6). This method is, however, sufficiently accurate for all the ordinary cases that occur in everyday practice.

* * *

Solder which has been exposed to damp air for some time and has become more or less oxidized on the surface will not give as good results as fresh solder.

ROLL PRESSURE AND POWER REQUIRED FOR ROLLING MILLS

In a recent issue of *Stahl und Eisen*, Prof. M. Hermann gives some formulas for obtaining the roll pressure and power required for rolling mills. The *Engineering Digest* gives a summary of these formulas, which apply to the rolling of rectangular sections.

Let A = reduction of sectional areas per pass, in square inches,
k = limiting stress of lateral extension of metal, in pounds per square inch,
t = reduction of thickness of billet per pass, in inches,
D = roll diameter, in inches,
v = velocity of bar leaving rolls, in feet per second,
a = arc of contact of billet with the roll, in degrees.

Then $\cos a = 1 - (t \div D)$, from which $\sin a$ may be found.

Force required to draw billet through the rolls: $F = 2k\,A$.

$$\text{Roll pressure in pounds: } P = \frac{k\,A\left(1 + \frac{1-\cos a}{2}\right)}{\sin a}$$

H.P. (exclusive of power required to run rolls empty)

$$= \frac{F\,v\left(1.1 + 0.12\,\frac{P}{F}\right)}{550}$$

The value of k is difficult to determine; it increases with the number of passes, and decreases with increasing temperatures. Prof. Hermann gives a table taken from Puppe's experiments in which k (average) for the fifth to eighth passes ranges from 6940 pounds per square inch at 2237 degrees F., to 10,042 pounds per square inch at 2091 degrees F.; and for the ninth to seventeenth passes from 7965 pounds at 2237 degrees F., to 11,547 pounds at 2091 degrees F.; or the mean value of k for the 12 passes ranges from 7609 pounds at 2237 degrees to 11,265 pounds at 2091 degrees.

Example.—Let $A = 4$ square inches; $k = 8000$ pounds per square inch; $t = 0.75$ inch; $D = 20$ inches; $v = 6$ feet per second.

Then, $\cos a = 1 - (0.75 \div 20) = 0.9625$. Hence $\sin a = 0.2712$.

$F = 2 \times 8000 \times 4 = 64{,}000$ pounds.

$$P = \frac{4 \times 8000\left(1 + \frac{1-0.9625}{2}\right)}{0.2712} = 120{,}000 \text{ pounds, approximately.}$$

$$\frac{P}{F} = 1.88$$

$$\text{H.P.} = \frac{64{,}000 \times 6(1.1 + 0.12 \times 1.88)}{550} = 925, \text{ approximately.}$$

* * *

It has been said of great scientists and engineers that they take nothing for granted and accept nothing as final simply because it has been done in a certain way since time immemorial. The really great engineer sees things as they ought to be rather than as they are, and that is the keynote of his preeminence in his chosen field. John Ericsson was one of those mechanical seers who are constantly at war with the mechanical superstition of their day. No better example could be cited to illustrate the fact that he would take nothing for granted, than a humorous incident from the days of his early childhood. When he was learning his alphabet, the shape of the letters did not suit his fancy and he had very decided opinions of his own about how they ought to be formed. He quickly perceived that the letters were symbols of sounds, and hence of arbitrary origin, and he forthwith proceeded to construct letters of his own design that to his mind possessed certain advantages of simplicity that were lacking in those of the time-honored Latin alphabet.

* * *

The estimate of Portland cement production in 1911, made by the United States Geological Survey, is 77,877,236 barrels. The production in 1910 was 76,549,951 barrels. The average factory price per barrel in 1910 was $0.891, and $0.867 in 1911.

THE TESTING OF SPIRIT LEVELS

By EQUA

In order to be able to produce accurate work on machine tools, it is necessary that they be set up level. Frequently there are complaints of the working of lathes and planers and the manufacturer is blamed for sending out a poor machine, when the real trouble is that certain parts of the machine are under a strain because of not having been set up level. Hence the spirit level is an important part of the equipment used by the machinist when erecting machinery.

The spirit level consists of a glass tube or cylinder, the inside of which is ground to a barrel shape. This tube is nearly filled with spirits of wine, ether, or some similar fluid, and hermetically sealed at each end. It is ordinarily spoken of in the shop as the "bubble," and is mounted in a brass tube having an opening at the top so as to make it possible to see the air space in the bubble or level. The brass tube is fixed to a block of brass or iron with suitable screws, so that it can be adjusted to be parallel to the base surface of this block.

It is readily understood that the chief part of the complete level is the glass tube, and the accuracy of the instrument depends entirely upon the curvature to which the inside of the tube has been ground. The makers of spirit levels use a device called a "level tester" for determining the accuracy of the bubble. A device of this kind is shown in the accompanying engraving, Fig. 1, the principle of the device being simply that upon turning the adjusting screw at one end of the bar or plate, this end is raised or lowered, so that the air space in the level will run from end to end. By means of this testing device it is possible to ascertain the curvature of the interior of the glass tube. The accuracy of a level is defined by saying that so many seconds of arc are equal to one-tenth or one-twentieth inch, etc. It will be seen in Fig. 1 that by turning the screw carrying the graduated disk we raise or lower the bar about the points *A* as pivots. The action of the screw is not the same as if the bar had worm teeth cut in it and the screw were a worm, but as the screw only has to move the bar through an arc of about two or three degrees, the error resulting from considering the action as that of a true worm and worm-wheel, is negligible. The adjusting screw on the testing device has 100 threads per inch and the graduated disk has 120 divisions. Each division should be equal to an angular movement of the bar about points *A* of one second. From this the distance from *A* to *B* can be determined. As the disk has 120 divisions and each division is equivalent to one second, one revolution of the screw will equal a movement of two minutes of the bar. The movement of the bar, however, is also equal to 0.01 inch for one revolution of the screw, and as there are 21,600 minutes in a complete circle, the total circumference of the circle having point *A* for a center and the distance *AB* for radius must be $10{,}800 \times 0.01 = 108$ inches. This circumference corresponds to a diameter of 34.377 inches and a radius of 17.188 inches, which is then the distance between *A* and *B*. It will be seen that for the accuracy of the device it is highly important that this distance be exact.

With a first-class testing device a supplementary plate having a screw of coarser pitch than that already mentioned is also provided. This supplementary plate is shown at *C* and *D* in Fig. 1. One of the purposes of this plate is to enable the testing device to be quickly adjusted, and another object in view is to test the accuracy of the fine pitch screw. Suppose, for example, that we wish to test the screw. We place a level on the test-bar, set the graduated disk at zero, place the testing device on the supplementary plate, and by means of the coarse screw we bring the air space near the center, carefully noting its location. Then we turn the fine screw half a revolution or 60 divisions and find that the air space has moved, say, 12 divisions. Then by means of the coarse screw we bring the air space carefully back to its first place, and then turn the fine screw another half a revolution or 60 divisions in the same direction and note how much the air space has moved. Should it have moved only 11½ divisions, for example, we know that the lead of the screw or its point is slightly out of true. This test should be carried out over various parts of the screw, and if it is found that one half of a revolution is slightly finer than the other half, there is nothing to do but to take the average of the error and proceed with the calculations on this basis. Of course it is still better to get a new screw, if one that is perfectly correct can be obtained.

When using the testing device it must be placed on a very firm foundation, free from vibration. The level to be tested is placed on the bubble carriers and allowed to come to rest. Should the bubble have been held in the hands just before putting it on the testing device, a few minutes must be allowed for the cooling of the tube and its contents.

The method of testing will be best understood by referring to an actual example. Suppose that the level to be tested is 6 inches long, and that it is divided into tenths of an inch. The three or four last divisions at each end may be ignored, as the level is rarely sealed up without disturbing these divisions. Of the sixty divisions on the level in question, however, fifty-four will be assumed to be serviceable. Assume further that the air space takes up twenty divisions.

The method of testing varies somewhat. Some testers will test every division, while others take the average of four or

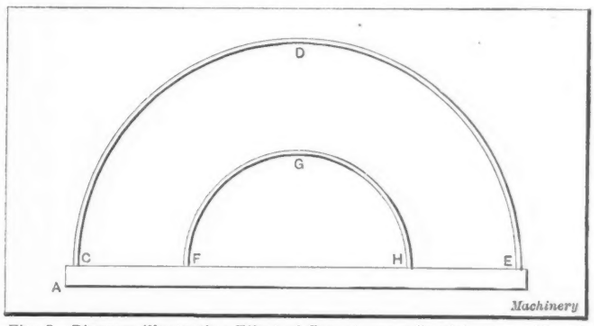


Fig. 2. Diagram illustrating Effect of Curvature on Sensitiveness of Level

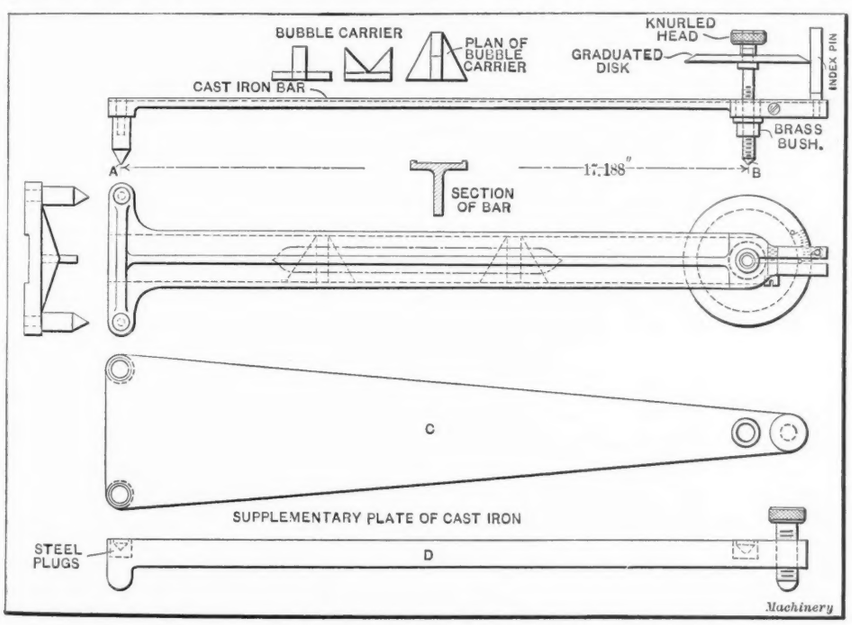


Fig. 1. Device for Testing Spirit Levels

five divisions. In this example we will take the average of every five divisions. The air space, at the beginning, is nearly at one end, and we note the lines between which it is located. Now the knurled head of the adjusting screw is carefully turned and the number of divisions on the graduated disk that are required to move the air space five divisions is noted. We find that it takes 60 divisions on the disk for the first five divisions on the level, and 63, 65, 65, 63, 61, 60 and 59 divisions, respectively, for the remaining sets of five divisions each. The average of this is 62 divisions on the graduated disk; therefore each division on the level is equivalent to $62 \div 5 = 12.4$ seconds of arc.

A level that varies more than 5 per cent from the average is spoken of as fair, one that varies 2½ per cent is termed good, and one that varies only ½ per cent is known as first-class. Hence the level tested in this case would be classed as a fair specimen. In making these tests, the temperature plays a considerable part. Nevertheless, a good level should show very little variation in its sensitiveness with a difference in temperature not exceeding 40 to 50 degrees F., although, of course, the air space will vary in length with this difference.

In order to understand how the curvature of the level affects its sensitiveness, it is perhaps best to take an extreme example. In Fig. 2 are shown two glass tubes *CDE* and *FGH*, bent to a semi-circular shape. One has a diameter of 12 feet and the other a diameter of 6 feet. As these tubes represent exactly half a circle, we will have 648,000 seconds of arc. The linear length of the larger tube, in inches, will be $(12 \times 12 \times 3.1416) \div 2 = 226.1952$, and of the smaller, 113.0976. Suppose that we have a girder 13 feet long and capable of being turned about *A* through an angle of 90 degrees. Now place the tubes on the girder, taking care to keep them in an upright position. The air space will be at *D* and *G*. Turn the girder through an angle of 90 degrees and the air space will have run to *E* and *H*, respectively. Now the air spaces in both tubes have run through 90 degrees, but the one in the larger tube has moved 113.0976 inches and that in the smaller tube 56.5488 inches. Thus we would say that the larger tube is twice as sensitive as the smaller, for it will be seen that to move the air space one inch in the larger tube, we need only to turn the tube through one-half the number of degrees required for the smaller tube. Of course in actual practice we never have to deal with tubes of this shape, but the principle is the same.

In all modern work the levels are divided on the outer surface to tenths and twentieths of an inch, except when they are divided according to the metric system. The following table gives the curvature of levels of various sensitiveness, the divisions on the level being in tenths of an inch:

Division of Arc of Circle to Each Graduation	Corresponding Diameter of Curvature of Level in Feet
1 second	3437.73
2 seconds	1718.86
5 seconds	687.54
10 seconds	343.77
20 seconds	171.88
30 seconds	114.59
1 minute	57.29
1 degree	0.954

All levels should be ground, although it often happens in cheaper ones that the glass tube is just bent to the approximate curve. These latter levels are not to be recommended except for work which does not require any particular accuracy.

The value of a division of a level may be found roughly by using a piece of metal about 12½ inches long and wide enough to support the level. Take, for instance, a piece of brass 12½ inches long and file away the lower surface so that it bears on two points exactly 12 inches apart. Put the level to be tried on it, bringing the air space near the center by putting packing under one of the bearing points. Note carefully where the air space is, and then put a feeler gage of 0.002 inch thickness under one of the bearing points of the brass bar. If then the air space runs say 0.1 inch, what is the value in seconds of arc of one division of the level, and what is the curvature to which the level has been ground?

The distance from the bearing point to the feeler gage is 12 inches; this is the radius of a circle whose circumference is 75.3984; hence 75.3984 inch is equivalent to 1,296,000 seconds of arc, and from this we find that 0.002 inch equals 34.3 seconds of arc; or in other words, each 0.1 inch on the level equals 34.3 seconds of arc. To find the curvature, we know that 34.3 is to 1,296,000 as 0.1 is to the total circumference of the curvature circle. Hence:

$$\frac{0.1 \times 1{,}296{,}000}{34.3} = 3749.27 \text{ inches},$$

which is the circumference of the curvature circle of the level, the diameter being 99.1 feet. This calculation indicates the simplicity of finding the sensitiveness of the level, and further if the user of a level does not know the value of a division on the level, he can by this means ascertain more easily how much out of level a piece of work is that he is setting up.

A good level is one of the most sensitive instruments made, and the utmost care should be exercised when using it. Levels are generally fixed in the brass tubes with plaster of paris. This method is satisfactory for all levels of an accuracy of about 5 seconds to 0.1 inch. For finer levels it will be found best to fix one end only with plaster of paris and the other end with cork, for if the level be fixed rigidly with plaster of paris at both ends, there will be a strain on the level at the extremes of temperatures at which it may be used, and as the coefficients of expansion of glass and brass are different, an inaccuracy is liable to occur. For fine levels it is also best to have an extra glass tube around them in order to prevent the heat of the hand from affecting them. In general practice, the length of the air space is from one-quarter to one-third of the length of the level. A level of 1 minute to 0.1 inch is most serviceable for general use. One having an accuracy of 30 seconds to 0.1 inch must be used on a floor free from vibration, and still finer levels are used mostly on surveying and astronomical instruments.

* * *

POSTAGE FOR FOREIGN COUNTRIES

By FINK

As an employe of a European firm which has an extensive correspondence with American manufacturers, the writer has observed that a great many letters from the United States are prepaid with only two cents instead of five cents, which is the regular foreign postage. It is true that letters from the United States to England or Germany need but two cents postage, but for every other European country the postage is five cents. Of course everyone who receives American letters insufficiently prepaid knows that the trouble is due to errors on the part of the clerks having charge of the mailing, but nevertheless, it is not exactly pleasing for the European business man to have to pay for the carelessness of the employes of an American firm, especially as this extra expense in a large house may amount to quite a considerable sum during the year, and this expense, with some attention, could be easily avoided.

The postage required to be paid on the European side is double that which is lacking, so that six cents has to be paid for every letter which is provided with a two-cent instead of a five-cent stamp. The writer feels sure that American manufacturers would regret the condition even more than the receivers of the letters, if they knew that their European customers sometimes pay six cents extra postage for practically every letter sent them. On the other hand, it is true that some firms always prepay the full postage on their letters.

Now I do not doubt that American manufacturers may have had this called to their attention in the past, but it is a matter that is easily overlooked. As a rather amusing incident in this connection, I might mention that I sent a letter similar to this to another highly esteemed mechanical journal in the United States, but my contribution was returned with an explanation that my remarks would not be of interest to the readers of that periodical. However, in spite of the fact that this journal considered my remarks too trivial to be worthy of publication, and that they contained nothing of interest to American manufacturers, the very letter in which my manuscript was returned was prepaid with only two cents instead of five cents, so that I had to pay the extra postage of six cents. I believe that this clearly shows that the matter to which I have called attention is one which American firms in general would do well to give some attention.

FEATURES OF APPRENTICESHIP SYSTEM AT THE G. E. CO.'S LYNN WORKS

By CHESTER L. LUCAS*

The apprenticeship system in vogue at the Lynn Works of the General Electric Co. was described in MACHINERY, in the April and September, 1906, numbers. As the apprentice department has recently moved into a large new building, and as some of the work being done at the present time is especially interesting from a mechanical standpoint, a description of the new quarters, and an outline of some of the work of the apprentices, may, perhaps, prove of interest.

The apprenticeship system, which is under the general supervision of Mr. Magnus W. Alexander, was started in February, 1902, with twelve boys. At the present time there are enrolled over three hundred boys, who have come from all parts of the United States, and even from Canada, to learn to be machinists and toolmakers, patternmakers, iron or brass molders, steam-fitters, etc. Although applicants for this course must be well qualified, educationally as well as physically, and come well recommended, and although the requirements as to home study and class standing are rigorous, there is always a long waiting list of young men who are looking for opportunities to take the course. This condition is due to the fact that it has become well known in mechanical circles that graduates of these courses are qualified to take responsible positions as skilled mechanics or as assistant foremen, and later as foremen and superintendents.

Fig. 1. A View in the New Training-room of the Apprentice Department

During the past year the apprentice department has moved into a large new building, designated as building No. 40 of the Lynn Works, where a well-lighted and ventilated training room for machinist and toolmaker apprentices is located. This room has over one hundred machine tools. The building also has large and well appointed class-rooms in which instruction is given in arithmetic, algebra, geometry, plane trigonometry, physics, mechanical drawing and tool-design, as well as in English and industrial history. This department occupies a space of 80 by 450 feet. A smaller, but equally well equipped training room for patternmakers is located in the wood-working building. A view of the machine shop is shown in Fig. 1, from which it will be seen that the shop is well appointed, of modern construction, and equipped with the best of machine tools. The General Electric Co. does not believe that "anything is good enough" for an apprentice, and the lathes, shapers and other machine tools are modern in every respect. It is also interesting to note that all machines are motor driven, so that no overhead belts are required.

A trial period of two months must be served by all applicants for positions on the course, after which time, if the applicant is found to be satisfactory and adapted for learning the chosen trade, he is permitted to sign the apprentice agreement. Compensation is paid, even during the trial period, at the rate of eight cents per hour for the first half-year, ten cents for the second half-year, twelve cents for the second year, fourteen cents for the third year, and sixteen and one-half cents for the fourth year. If the four years' work has been satisfactorily completed in every respect, a cash bonus of one hundred dollars is given to the graduate. The courses for molders and steam-fitters, however, are completed at the end of two years, and the rate of compensation is ten cents per hour for the first half-year, twelve cents for the second half-year, and fourteen cents for the second year, and graduates receive a bonus of fifty dollars at the completion of the course.

The company also maintains apprenticeship courses for high-school graduates who, during a three-year period, desire to fit themselves for efficient service as draftsmen, designers, engineers, electrical testers, erection and installation men, or salesmen. Their initial training consists of well supervised machine work in the apprentice training-room. These apprentices receive ten cents per hour for the first half-year, twelve cents for the second half-year, fifteen cents for the second year, and twenty cents for the third year. A bonus of seventy-five dollars is also paid upon completion of the course. The class-room work is of a high order, and a high standard of work is maintained in the shops and testing departments.

Mr. Charles K. Tripp is the superintendent of apprentices and is in charge of all work. The educational feature of the course is a strong attraction to all, and a great deal of attention is given to this side of the work. The educational work is under the direction of Major A. W. Lowe, and a corps of instructors instructs the boys in those subjects that are closely allied to their work. Fig. 2 shows the interior of a class-room. Mr. Tripp is here instructing a class of apprentices in the proper methods of sharpening lathe tools, illustrating on the black-board methods which are right as contrasted with those which are wrong. As will be noticed, the apprentices are provided with pencils and paper in order that they

* Associate Editor of MACHINERY.

may take notes, for they are expected to remember the points brought out in these lectures when the time comes for their practical application in the shop.

The chief aim of the educational side of this course is to develop proper thinking on the part of the boys, and to familiarize the apprentices with such problems as are apt to come up in their everyday work. Practical examples are always selected to impress upon their mind the value of the information they get. Many boys are dropped from the course

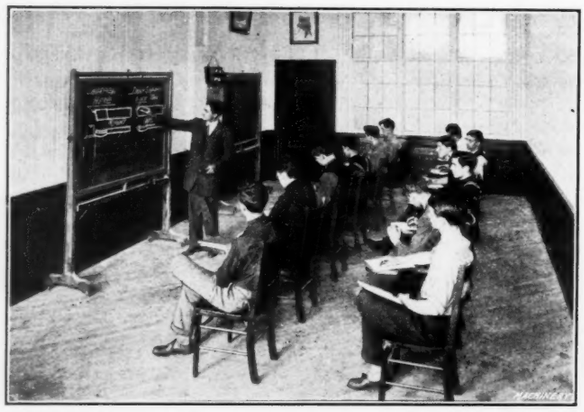


Fig. 2. Another of the Class-rooms with the General Foreman showing Methods of Tool-sharpening

on account of their inability to keep up with the class work, this inability being due either to natural dullness or to indifference.

Work done by Apprentices

The following examples are given to convey an idea of the class of work that the apprentices perform in the training-room, before being placed in the various departments of the plant. All of the work described, as well as many of the tools

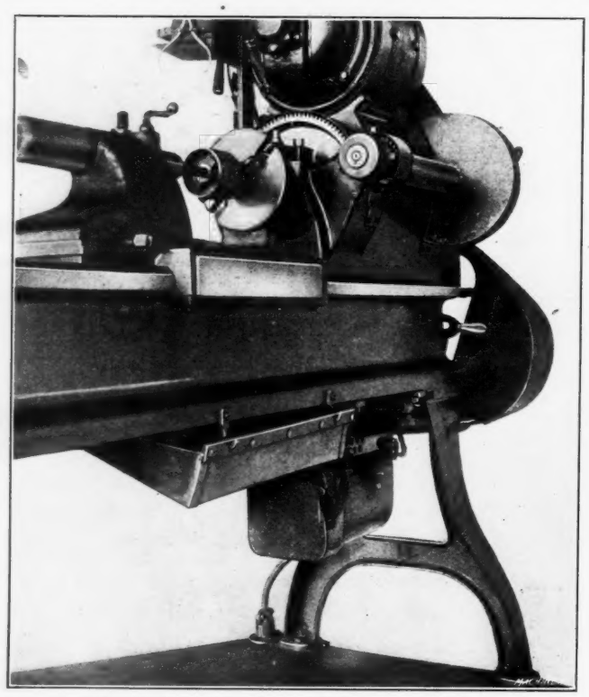


Fig. 4. Chip-pan and Methcd of attaching to Lathe

used for doing the work, has been done by apprentices more or less advanced in the course.

T-slotting in the lathe, as shown in Fig. 3, is an unusual operation, but in the apprentice department it is employed to good advantage on turbine work. The piece of work—a turbine valve shown at *A*—is held in a block *B*, bolted directly to the carriage of an old lathe. The cutter *C* is then held in the universal chuck, and a straight slot milled by feeding the cross-slide on to the cutter to the required distance. This operation is followed by inserting T-slotting cutter *D* in the chuck. This cutter mills the bottom of the slot to the proper size and shape. This method has the advantage of cheapness, as it requires only an old lathe instead of a first-class milling machine, and it certainly produces a very good job.

The simple little contrivance shown in Figs. 4 and 5 helps to keep the floors beneath the lathes clear of oil and chips. Fig. 4 shows the pan in position. In cleaning out the pan, it is

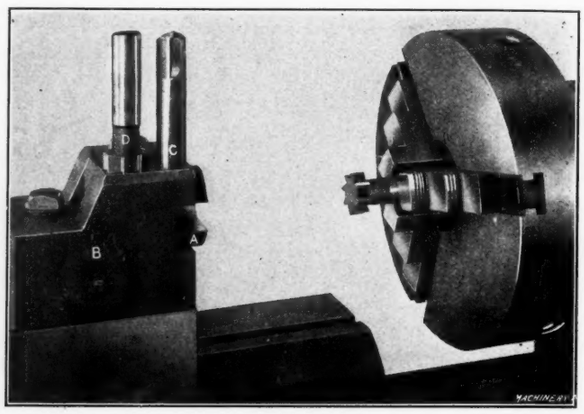


Fig. 3. Using a Lathe for T slotting

simply unlatched at the front and allowed to drop, and the chips and oil are caught in a regular dirt pan, as shown in Fig. 5.

A little kink that often proves useful in shops where comparatively little cutting-off is done, is the method of cutting-off short duplicate lengths of round stock on the lathe, as shown in Fig. 6. The solid chuck grips the work, while the other end is supported by the tail-center. The cutting-off, of course, is done with the usual cutting-off tool, and the dis-

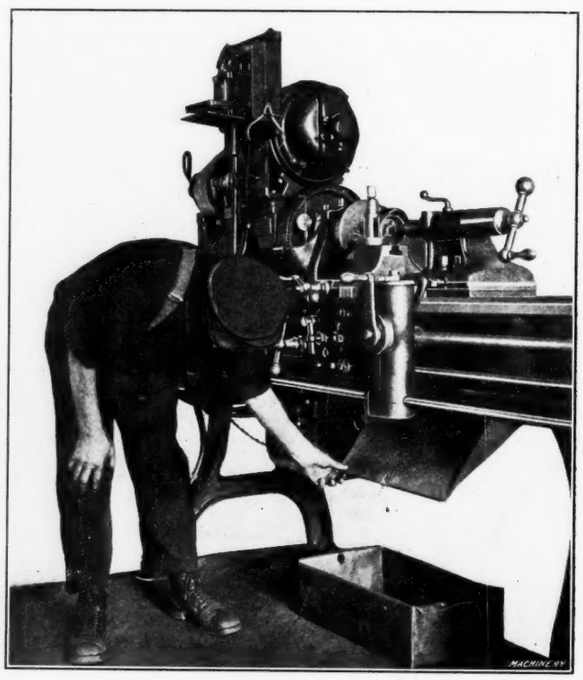


Fig. 5. Removing the Chips and Oil

tance the bar enters the chuck governs the length of the pieces.

Valve-seats, a group of which is shown finished in Fig. 7, present some unusually interesting machining methods. At *A*, Fig 7, is shown a rough casting from which the valve-seats are turned, and in Fig. 8, is shown a line-engraving of the valve-seat. It is important that these castings be internally gripped and held central on the arbor by the three points *M*, shown in Fig. 8. For this purpose the special arbor

shown at *B*, Fig. 7, is employed. This special arbor consists of a steel core *C*, on which is slidably mounted a sleeve *D*, one end of which terminates in a tapered flange. At the opposite end of this core is permanently located a collar *E* in which three pins are equidistantly placed about the flange. These pins are so supported that when the sleeve *D* is moved toward the collar *E*, the pins are forced outward due to the action of a taper bearing under the pins.

In operation, the casting is slipped over the arbor, care being taken to locate the three internal spots *M* over the pins that extend from the arbor. Sleeve *D* is then inserted and

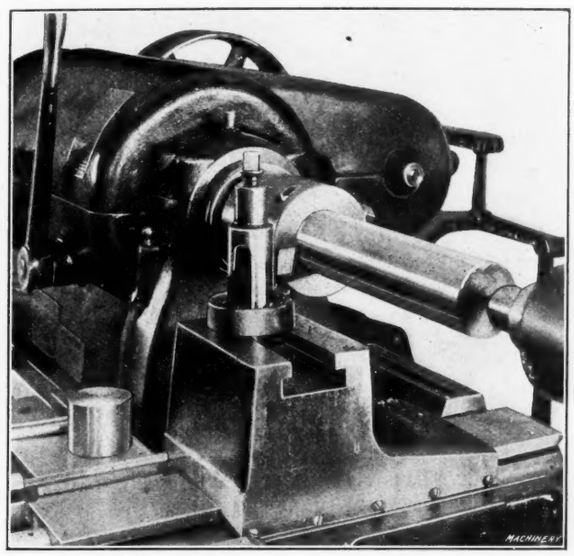


Fig. 6. Cutting-off Short Pieces of Stock

nut *G* tightened. This operation forces the three pins to grip the casting internally, while the tapered flange on the sleeve centers the other end of the casting. In this position the outside of the casting is turned. Next, the casting is removed from this arbor, and one end is held in a chuck while the body of the valve-seat is supported by a steady-rest, thus leaving the interior clear for machining. After being rough-bored, reamer *H* is run through, after which the succeeding counterboring tools, *I*, *J*, and *K* are used. Each of these tools is held in the tail-center of the lathe and each counterbores some particular part of the valve-seat. The interior of the valve-seat being thus finished, it is finally slipped on the arbor *L* and the exterior of the work polished with emery cloth.

Large numbers of cast-iron pulleys are turned in this department, this work being one of the first jobs that the prospective machinist receives. In finishing these pulleys considerable filing must be done, and with the ordinary faceplate and dog, there are plenty of chances for a novice to have his jumper-sleeve caught, with possible injury to himself. To overcome this danger, the lathes in the apprentice department are fitted with faceplate guards, consisting of a piece of sheet metal bent into circular form and fastened to the edge of the faceplate with small screws. The guard (see Fig. 9) extends over the dog, and there is no possible chance

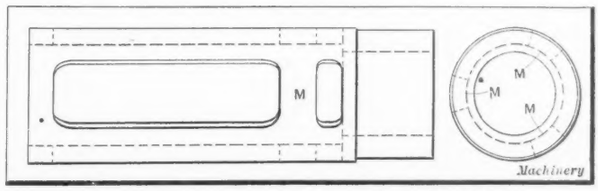


Fig. 8. Turbine Valve-seat Casting before Machining

for any part of the workman's sleeve or arm coming in contact with the dog.

In connection with the pulley work there is a splining operation, which is interesting on account of the method by which the splining bars are made. The bar is mounted on

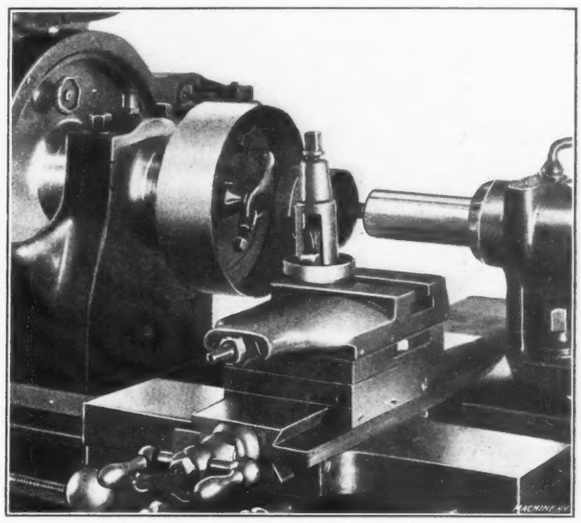


Fig. 9. Guard for Faceplate and Dog when filing in the Lathe

the table of a vertical milling machine, with one end slightly raised. The holes for the teeth are then milled to the same depth, measured from the surface of the table. This, of course, results in each hole being slightly shallower than the preceding hole. As the teeth are made the same length, it will be readily seen that when soldered in place, they will project from the bar with regularly increasing amounts.

Fig. 10 illustrates the way in which the apprentices are taught to run the various machines, the example illustrated being a grinding machine. The apprentice who is to learn to run the machine is instructed by an older apprentice who has already performed work on this machine in a satisfactory

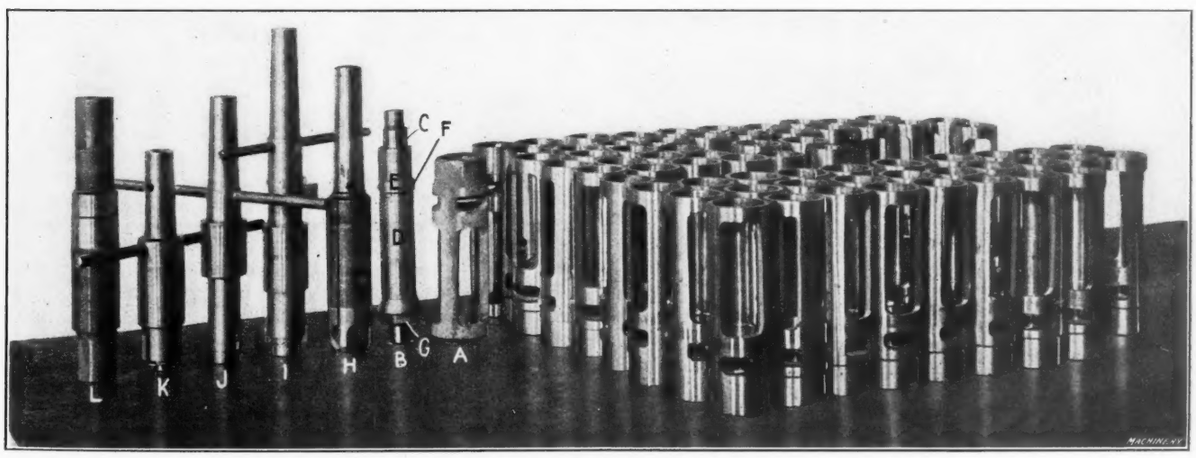


Fig. 7. Turbine Valve-seats and Tools for Machining. A Specimen of Apprentices' Work

manner. The younger apprentice operates the machine under the guidance of the more experienced boy, and the two work together until the younger apprentice is proficient in handling the work alone. This illustration shows the operation of grinding shafts, of which a great many are used by the General Electric Co., in building small motors. As soon as the younger boy becomes experienced in handling this machine, the older apprentice is taken off and started at work on some other job, and, in due time, the younger boy proceeds to instruct a new recruit. All of this work, of course, is under the supervision of the foreman and his assistants.

In Fig. 11, one apprentice is shown running the machine

Fig. 10. How One Apprentice instructs Another to operate a Grinding Machine

while the other, who is more experienced in the work, is measuring the finished motor shafts with micrometers. This work, being regular production work, is extremely good practice for apprentices to work upon, as the limits of accuracy are held to within 0.0005 inch. The grinding machine here shown was built by apprentices. The illustration also shows

Fig. 11. Grinding Small Motor Shafts. Grinding Machine made by Apprentices

a simple type of homemade shop-stand, built up of iron plates and short lengths of pipe, the whole being held together by long bolts with nuts at the top.

Fig. 13 shows an extremely convenient type of dog used for driving work on the grinding machine. The tail of the dog, which comes in contact with the driving pin, is hinged in the frame of the dog. The hinged end is made cam-shaped so that the slightest pressure upon the tail causes the cam to grip the work, and as the pressure increases, the cam grips the work still harder. The eccentric is kept normally on the work by a spring *A*. This dog is the design of Mr. Tripp and is used exclusively for small grinding work in the apprentice department.

In Fig. 12 is shown an interesting example of turning. The piece of work is a bronze oil deflector, approximately six

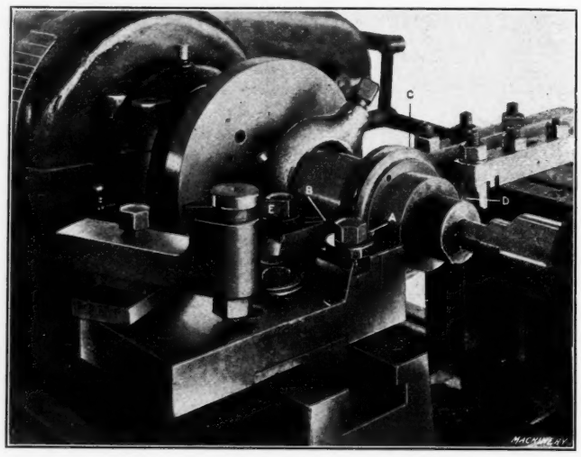


Fig. 12. Multiple-turning an Oil Deflector

inches in diameter, made from large bronze tubing cut to lengths slightly longer than the finished pieces. It is necessary that the inside of this piece be perfectly smooth and accurately sized within 0.0005 inch. This sizing is done by forcing a perfectly smooth arbor through the hole after it has been brought approximately to the required internal diameter. This operation is practically a planishing operation, in that it leaves the metal with a fine finish—far better than could be produced by reaming. Another important reason for using this method in preference to reaming, is the fact that reamers dull very quickly in cutting this hard bronze.

The method of doing the lathe work on this piece is interesting, because it involves multiple-turning. After the interior of the piece has been finished, it is held upon an

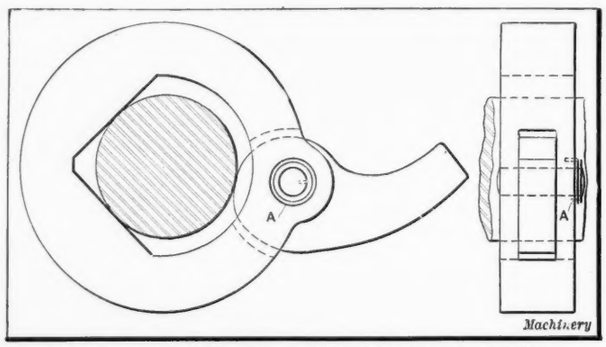


Fig. 13. Dog with Cam-grip; used in Driving Work for Grinding

arbor and placed between the centers of the lathe. Tools *A* and *B* are used for facing the sides of the work, at the same time sizing the piece. These tools are, of course, operated by running in the cross-feed of the carriage-slide. As soon as this operation has been completed, the cross-slide is withdrawn, bringing tools *C* and *D* into contact with the surface of the work. These tools each cut away certain parts of the metal, after which tool *E* is set to cut the grooved section near the center of the oil deflector. In this manner the pieces are finished very quickly and accurately.

In Fig. 14 is shown an example that aptly illustrates the work of the apprentices in fixture making. The operation being done is that of milling a turbine detail, and not only is the work done by apprentices, but the fixture used has also been made by them. The method of doing this milling, in common with many of the other jobs that have been previously described in this article, originated with Mr.

Tripp, who is constantly working out new ideas to be carried out by the apprentices. Referring to the illustration, the work *A* is clamped on the faceplate *B*, of a fixture *C*. It is located at the bottom by set-screw *D*, and at the top by latch *E*, which engages in the longitudinal slot in the work. The seats for the work are V-blocks *F*. The faceplate *B* is removable from the body of the fixture; it is located accurately by two removable dowel pins *G*, and held in place by four swing-bolts *H*.

It will be noticed that one section of the cut is slightly deeper than the other part, a condition that is met by using cutters of different diameters. As soon as one cut has been made in the work, the top half of the fixture is loosened and reversed, and the second cut is made at the other end of the turbine part. While this cut is being taken, the apprentice clamps a new part in a duplicate faceplate, and at the completion of the cut, he simply removes the top half or faceplate of the

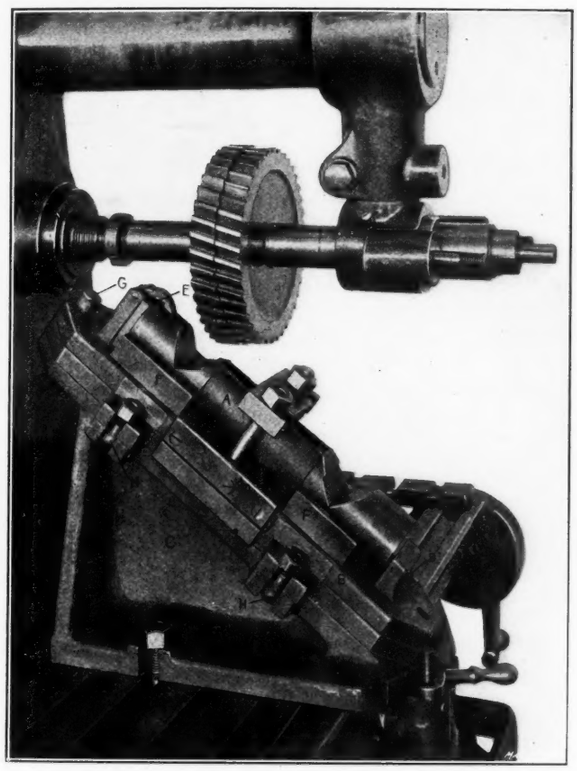


Fig. 14. Fixture employed in milling Turbine Parts

fixture, replacing it with the duplicate faceplate that has a new piece in it, and is ready for milling. In this manner the machine is kept at work all the time.

There are many other jobs done by the General Electric apprentices that are worthy of description. Screw-cutting bench lathes and other machines have been built complete in this department, and some unusually good punch and die work and general toolmaking has been done, but enough has been said to make it plain that the apprentices on this course get "real work" to do.

* * *

During the last thirty-six years the fire losses in the United States, according to an article by Mr. S. G. Koon in the *Engineering Record*, have amounted to more than $5,000,000,000. This is more than seven per cent of the average estimated national wealth during this period. The fire loss per capita is considerably over two dollars a year, which is about six times the fire loss per capita in some of the leading European countries. When it is known that over ninety-five per cent of all fires in buildings equipped with automatic sprinklers are either completely extinguished by the sprinklers or held in check so as to be easily handled by the firemen, it is evident that these enormous fire losses are not necessary. A department store with a sprinkler system stopped the progress of the Baltimore fire. Had the building in which this fire started been properly protected in this manner, there would have been no conflagration to stop.

DAD'S BOY

By A. P. PRESS

We had a new man come in lately. This is not, in itself, an unusual thing, for new men come in every day. In fact this one came in with a "bunch" of five; but he "stuck out" from the rest, although he did not put himself forward—he just stuck out, anyway. He had on a blue woolen shirt, but it was clean; and he had blue eyes—and they were clean too. He did not have much of a kit—none of the boys do nowadays. A kit is in the way on the bench if kept in a chest, and on the set-up job it is not needed anyhow; but what tools this new man had were first-class.

He started in just the same as the rest of the men, and no favors were shown him, but one thing we noticed was that he "peeled off" before he started, the same as the molders do, and put on some rough clothes.

The floor boss came along past the desk, that noon, just as we were eating lunch, and said:

"Say, but that new man is all right." (He didn't say which new man, but we all knew who he meant.) "He showed me how to get the angle on that big brace without a protractor and it came out right, just as the drawing called for. You can't get a protractor on it very well anyhow—there is no planed surface to work from."

"A good man, is he?"

"He sure is," was the reply, and the matter was dropped.

About a week after that we wanted a nice lathe job done. It was a kind of a government job. It happened this way. We broke down one of the big cranes, and it was due to carelessness, so we hated to ask the office for an order to fix it, as that would mean a lot of explanations as to how it was done. It only needed a new bushing with a taper hole in it to make it as good as new, so we asked the floor boss if he had a good lathe hand in the gang.

"Sure and I do not think of one, sir; but wait a minute and I'll ask that new man and see what he knows."

Back he came in five minutes. "Yes, sir, the new man says he can do anything in the way of a lathe job; and that is not all—he has a pair of 'mikes' and a pair of vernier calipers in his coat pocket, both in little cases."

We got the use of a good lathe in the experimental room and sent the new man in there with a sketch showing what was wanted, and a solid casting to cut it from. Along in the afternoon he came out with the job and fitted it into the crane—it *was* a fit, too—and went back to his floor work, and said nothing.

A week after this the man on the big planer was taken sick, and word came from the planing job to ask if we had a man who could take his place for a week, as the planer had all it could do every hour of the day. We called in Mike, the floor boss, and put it up to him.

"Sure, and that new man does have a machinery paper, and he is reading most every noon; I will ask him." Back he came and said, "Yes, he says he has run big planers and is not afraid to take hold of this one—in fact, he is very willing to do it." So on the planer he went and he made good, and stayed there until the regular man got back again; and then he went back to the floor.

A month went by, and one morning we got a telephone message from Mike. "Sure," said he, "and I was going upstairs with a hod of coal; and I fell and hurted my ankle. The doctor says that it will be a week before I can get in." Well, we were stuck, for that meant that we either had to find a piece of stock on the floor that we could hammer a floor boss out of, or be boss ourselves. The new man was the first one that came into our mind, so we went gunning for him at once.

"Did you ever handle any men?"

"Yes, sir, on several jobs, sir," was the reply.

"How many?"

"Oh, anywhere from five to fifty," was the quiet reply.

"Can you take hold of this gang and run it until Mike gets back?"

"I can try," he answered.

"Go ahead."

And "go ahead" he did; and although Mike's one week with his injured leg, stretched out into three, things ran so smoothly that we should never have known he was out—as far as the work was concerned. Mike came back at last, and then our curiosity got the best of us, and we called the new man into the office.

"See here, now, what are you doing here? You have been here four months and you have shown that you are an expert lathe hand, a good planer hand, and also a good floor boss—and still you are working for a journeyman's pay. We know drinking is not the trouble."

"Well, boss, you see it is like this: Dad is superintendent of the Smith Co. (naming one of the largest concerns in the country) and it has always been his brag that he was a self-made man and came up from the ranks. He said that any boy of his had got to do the same—and that is just what I am doing now. I started in three years ago in the lumber mills of Vancouver, worked my way along to Seattle, put in a year in 'Frisco, and then worked my way through the gulf shops to New York. I put in nine months in a big garage there before I came here—and I would like to respectfully give you notice that I wish to leave next Saturday night. I am going across to the old country for a year in France and on the Continent. Then I am going home to Dad."

Now, we have not the pleasure of the acquaintance of "Dad," but we certainly have the highest respect for him and his method of bringing up the boy—and we should like to be in Dad's shoes when the kid gets home.

* * *

TABLE OF ALLOWANCES AND LIMITS

FOR DRIVING, PULLEY, RUNNING, SHRINK AND SLIDING FITS

By H. M. NICHOLS*

In manufacturing machinery where the parts must be interchangeable, it is necessary to have some standard of allowances and limits in order that parts made at different times will go together without fitting. The accompanying table gives the allowances and limits for sizes from zero up to 8 inches for driving, pulley, running, shrink and sliding fits. The allowances are in all cases added to the even dimensions to determine the dimension that is put on the drawing for the mechanic to work to. The limits are given after the important dimensions on the drawing, and all pieces must be made to the degree of accuracy called for by these limits; that is to say, if the limits for a particular piece are +0.001 and —0.000, it must at least caliper to the size and must not be more than 0.001 inch over to pass the inspector.

As an example, suppose we have a 3-inch shaft and a collar to be shrunk onto it. Referring to the accompanying table we find that there is no allowance for the bore, and consequently the dimensions for the bore of the collar would be written $3.000\ ^{+0.000}_{-0.0005}$. The allowance for the shaft is 0.003 inch, so that the dimensions for the shaft would be written $3.003\ ^{+0.0005}_{-0.000}$.

It is customary to write dimensions that have to be accurate to the thousandth part of an inch in the form of a decimal, annexing ciphers in case a particular dimension happens to come out an even figure. All other dimensions are written in sixteenths or multiples of sixteenths. This enables the workman to pick out all dimensions requiring accurate work. The limits are usually given in small figures immediately following the main dimensions and a little above the main dimensions. Some concerns have letters to represent their standard limits which they add to the general dimensions requiring limits.

[While the values given in the table for shrinkage and force fits are all right for average conditions, they cannot be used in all cases, the allowance to be made depending on the length of the work, diameter of the hub, character of the bore, and numerous other conditions. For a more extended treatment of the subject, reference should be made to the article on "Shrinkage and Force Fits in the Bradford Shops," which appeared in the August, 1911, number of MACHINERY, engineering edition, and also to the two articles by William Ledyard Cathcart, entitled "Shrinkage and Force Fits," in the April and May numbers of MACHINERY, engineering edition.—EDITOR.]

TABLE OF ALLOWANCES AND LIMITS

Diameter in Inches	Driving Fit			Pulley Fit		Running Fit			Shrink Fit			Sliding Fit		
	Bore, No Allowance	Shaft		Bore, No Allowance	Shaft, No Allowance	Bore		Shaft, No Allowance	Bore, No Allowance	Shaft		Bore		Shaft, No Allowance
	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Allowance, Inches	Limits, Inches	Limits, Inches
0 to ¼	+0.000 −0.00025	0.000	+0.00025 −0.000	+0.00025 −0.000	+0.00025 −0.000	0.001	+0.000 −0.00025	+0.000 −0.0005	+0.000 −0 000.5	0.0005	+0.00025 −0.000	0.0005	+0.000 −0.00025	+0.000 −0.0005
¼ to ½	+0.000 −0.00025	0.000	+0 0005 −0 000	+0.0005 −0.000	+0.0005 −0 000	0.001	+0.000 −0.0005	+0.000 −0.0005	+0 000 −0.0005	0.00075	+0.0005 −0.000	0.0005	+0.000 −0.00025	+0.000 −0.0005
½ to 1	+0 000 −0.00025	0.0005	+0.0005 −0.000	+0.0005 −0 000	+0.0005 −0.000	0.001	+0.000 −0.0005	+0.000 −0.0005	+0 000 −0.0005	0.0015	+0.0005 −0.000	0.00075	+0 000 −0.00025	+0.000 −0 0005
1 to 1½	+0.000 −0.0005	0.00075	+0.0005 −0.000	+0.0005 −0.000	+0.0005 −0.000	0.0015	+0.000 −0.0005	+0.000 −0 0005	+0.000 −0.0005	0.002	+0.0005 −0.000	0.001	+0 000 −0.00025	+0.000 −0.0005
1½ to 2	+0.000 −0.0005	0.001	+0.0005 −0.000	+0 001 −0.000	+0.0005 −0.000	0.0015	+0.000 −0.0005	+0 000 −0.001	+0.000 −0.0005	0.0025	+0.0005 −0.000	0.0015	+0.000 −0.00025	+0.000 −0.0005
2 to 3	+0.000 −0.0005	0.0015	+0.0005 −0.000	+0.001 −0.000	+0.0005 −0.000	0.002	+0.000 −0.0005	+0.000 −0.001	+0.000 −0.0005	0.003	+0.0005 −0.000	0.002	+0.000 −0.00025	+0.000 −0.0005
3 to 4	+0.000 −0.0005	0.0015	+0.001 −0.000	+0.001 −0.000	+0.001 −0.000	0.002	+0.000 −0.001	+0.000 −0.001	+0.000 −0.001	0.004	+0.001 −0 000	0.002	+0 000 −0.00025	+0 000 −0.001
4 to 5	+0.000 −0.0005	0.00175	+0.001 −0.000	+0.001 −0.000	+0.001 −0.000	0.003	+0.000 −0.001	+0 000 −0.001	+0.000 −0.001	0.0045	+0 001 −0.000	0.0025	+0 000 −0.0005	+0.000 −0.001
5 to 6	+0.000 −0.0005	0 00175	+0.001 −0.000	+0 001 −0.000	+0.001 −0.000	0.003	+0.000 −0.001	+0.000 −0.001	+0.000 −0.001	0.005	+0.001 −0.000	0.003	+0.000 −0.0005	+0.000 −0.001
6 to 7	+0.000 −0.0005	0.002	+0.001 −0.000	+0.001 −0.000	+0.001 −0.000	0.004	+0.000 −0.001	+0.000 −0.001	+0 000 −0.001	0.0055	+0.001 −0.000	0.004	+0 000 −0 0005	+0.000 −0 001
7 to 8	+0.000 −0.0005	0.002	+0 001 −0.000	+0 001 −0.000	+0.001 −0.000	0.005	+0.000 −0.001	+0.000 −0.0015	+0 000 −0.001	0.006	+0 001 −0.000	0.004	+0.000 −0.0005	+0.000 −0 001

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MAKING PISTON RINGS*

By C. A. ROGERS†

The subject of making piston rings has been discussed before, but as this is an interesting problem in machine shop practice, the writer feels that there is still more to be said. A great many mechanics insist that piston rings must be ground, yet I have seen very few ground rings that were parallel sideways, and consequently they would not have a perfect bearing when placed in the cylinder. The piston ring, the manufacture of which is to be described in the following, is for a 4-inch cylinder and is shown in Fig. 1. Fig. 2 shows the casting from which the piston rings are made, while Fig. 3

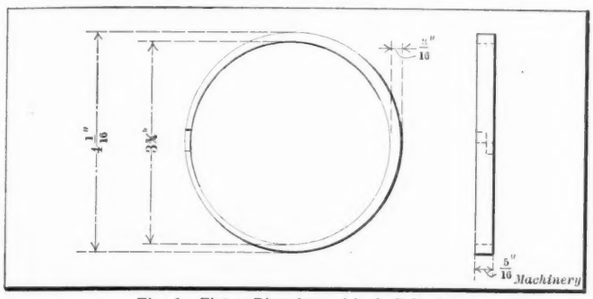

Fig. 1. Piston Ring for a 4-inch Cylinder

is a fixture fitted to the lathe spindle for holding the casting shown in Fig. 2.

The fixture shown in Fig. 3 consists of a casting *A*, fitted to the nose of the spindle and which is machined out on the front end to receive a block *B*. This block is counterbored to fit the external diameter of the casting shown in Fig. 2, the latter being reduced on one end to 4⅛ inches. The casting is held in the block *B* by a binding screw which securely holds

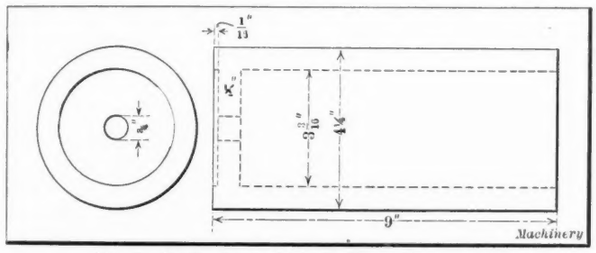

Fig. 2. Casting from which the Piston Rings are cut

the casting while it is being turned, bored, faced, and the rings cut off. The block *B* is provided with a pin *C*, which locates it in two positions so that the castings for the rings can be turned eccentric. The block when located in the desired position, is held by cap-screws as shown.

The casting is turned, faced and cut up into rings by means

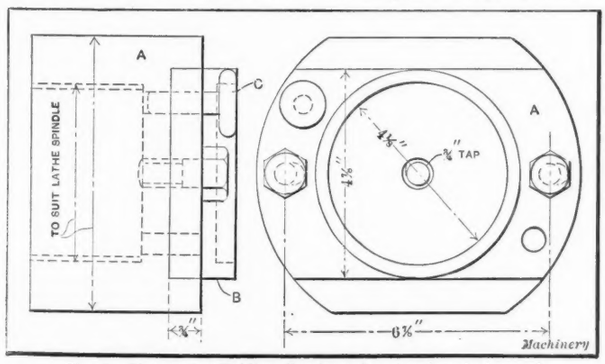

Fig. 3. Fixture for Holding Casting when turning, facing and cutting-off Piston Rings

of tools held in the turret toolpost, shown in Fig. 4, which comprises three blocks of machine steel. The turning tool *A* is used for rough turning; tool *B* for finishing; *C* for cutting off; and *E* and *F* for side facing. The first operation after placing the casting in the fixture, Fig. 3, is to rough down the external diameter with the tool *A*, Fig. 4, at a feed of 1/16 inch per revolution, and a surface speed of 80 feet per minute, leaving 1/32 inch for the finishing tool *B* to remove. Finishing tool *B* is operated at the same speed as tool *A*, and finishes the casting to the required diameter.

Cut-off tool *C* is then brought into position, and is used to face off the outer end of the casting. The carriage is then

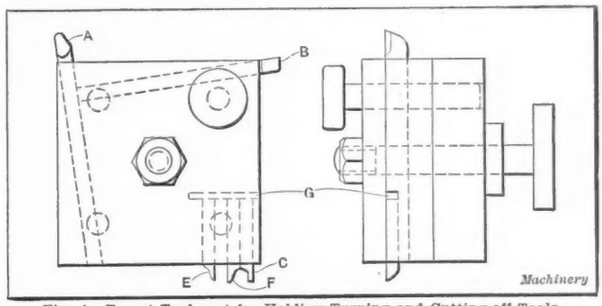

Fig. 4. Turret Tool-post for Holding Turning and Cutting-off Tools

moved 5/16 + 0.020 inch, and the cut-off tool put in to within 1/64 inch of cutting the ring off. The carriage is again moved 5/16 + 0.020 inch, and while the groove is being cut to form the second ring, the two side facing tools *E* and *F* face the first ring and cut it off. This order of operation is repeated until the casting is cut up into rings.

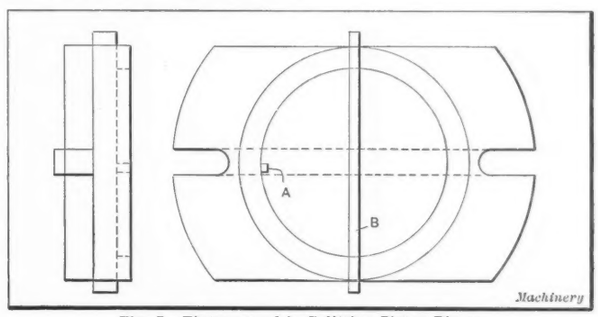

Fig. 5. Fixture used in Splitting Piston Rings

After the rings are turned externally and cut off, they are taken to the milling machine and placed in the fixture shown in Fig. 5. This is a fixture for holding the rings while the slot is milled, a cutter 0.197 inch wide being used. The fixture is set off center, an amount equal to half the thickness of the cutter—0.0985—and all the rings are milled on one side. Then

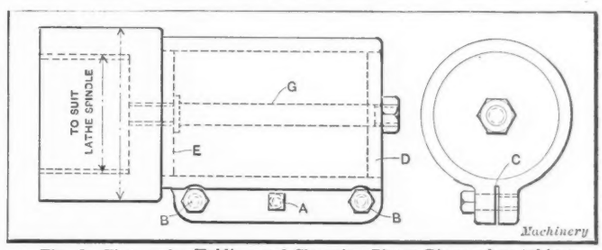

Fig. 6. Fixture for Holding and Clamping Piston Rings when taking the Finishing Cut

the piece *A* is slipped into position to fit the slot already cut, when the rings are milled on the other side.

Following the milling of the rings they are taken back to the lathe and placed in the fixture shown in Fig. 6. This consists of a clamping sleeve which will hold as many rings as are cut off from the casting. To make the sleeve ready for holding the rings, the set-screw *A* is backed out and the binding screws *B* tightened, so that the sleeve is cracked open at *C*; then the fixture is filled up with rings, leaving sufficient room for the washers *D* and the projection *E* on the fixture. The retaining sleeve holding the rings is now slipped over the stud *G*, the washer *D* put on and the nut tightened. The binding screws *B* are now loosened, and the set-screw *A* tightened slightly, when the sleeve can be easily removed. A center is provided in the end of stud *G* so that it can be supported with

* For additional information on this and kindred subjects, see "Automatic Piston Ring Peening Machine," August, 1911; "Fixtures for Machining Eccentric Piston Rings," April, 1910, and articles there referred to; "Turning Gas Engine Pistons in a Turret Lathe," April, 1910; "Making Accurate Automobile Engine Pistons," January, 1910; "Automobile Factory Practice," January, 1910, engineering edition; "Automobile Factory Practice," October, 1909, and other articles there referred to.

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the tailstock center when taking the finishing cut. The finishing tool *B* shown in Fig. 4 is used for this last operation.

As the sleeve is bored the same size as the cylinder (plus 1/32 inch to allow for turning), and as the rings are closed together when they are placed in it, they are thus turned when in their compressed condition so that they fit the cylinder of the engine snugly. The total time required to make these rings is five minutes each, and when made on a good engine lathe equipped with fixtures as illustrated, a very good job will be the result.

Referring to Fig. 5, the strip *B* is used for pulling the rings from the fixture. They require no holding in this fixture, as the cutter should be fed down from the inside, and any tendency for the rings to fly up on the opposite side is easily overcome by holding them down by the fingers. If the rings were clamped down, the time required for clamping would be nearly as long as that required for milling. The strip *G*, Fig. 4, is set in a milled slot to prevent the cut-off and side facing tools from slipping back. The two side facing tools should be packed apart with tin foil so that they can be adjusted for wear, as the rings should be a very close fit in the grooves of the piston.

* * *

SPECIAL ACME-THREAD MACHINE TAPS

By FRANK LANG*

Having had considerable trouble in making machine taps with Acme threads due to the change of the lead in hardening, the writer designed the type of tap shown in Fig. 1. This tap has proved practical and has given very good results. An accurate thread is produced, there is less heating in tapping, and a greater number of pieces can be tapped in the same time, with less chance of breakage. One tap, 1 15/16 inch in diameter with two threads per inch, left-hand, was used for tapping seventy-five pairs of Le Blond heavy-duty lathe half-

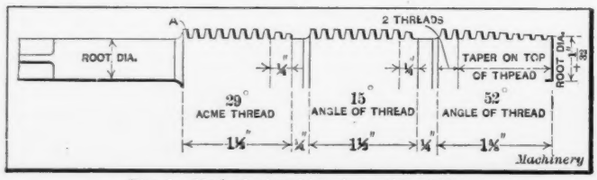


Fig. 1. Method of making Acme-thread Taps

nuts, and not a scratch could be seen on the thread when the last pair was removed from the jig; the tap was ground twice.

When making this tap a tool is first ground to a 52-degree angle, as indicated by the gage shown in Fig. 2. This tool is used for threading the first third or roughing part of the tap. The thickness of the tooth at the bottom of the thread in the tap is made 0.010 inch less than the figures given in a table of the standard Acme thread dimensions. The next third of the tap is made with a tool having a 15-degree angle, the

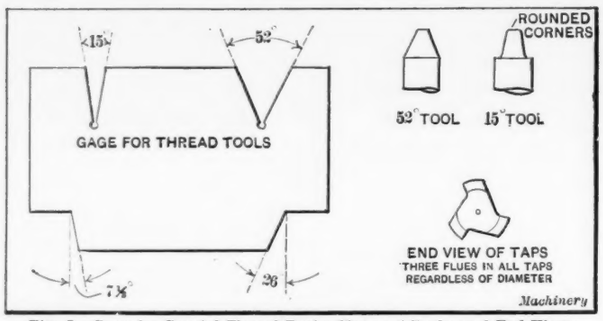


Fig. 2. Gage for Special Thread Tools, Shape of Tools, and End View of Fluted Taps

flat at the top of the thread being made 0.010 inch smaller than the Acme standard. A small round on each corner of the tool is made as shown in Fig. 2. This is a good feature as it makes the tap less liable to break when straightened after hardening. The last third of the tap is made with a regular Acme thread, except that the thickness at the bottom of the tooth is 0.005 inch less than standard, in order to allow this amount to be removed by a hand tap.

The diameter of the shank is made equal to the root diameter, and its length depends on the length of the piece to be tapped. The square in this case is hardened and tempered, as this tap is driven by a tap socket having its square at the outer end, so that the shank has no bearing in the socket and the square does all the driving. A small round corner should be left between the sides of the square, as this strengthens the square. The tap shown in Fig. 1 is ¾ inch in diameter with six left-hand Acme threads. The one-half of a thread shown at *A* should be ground off from each tap, as otherwise it may become distorted in hardening and mar the tapped pieces, and the trouble may never be located. In chasing the threads in the tap, a ⅜-inch square piece of high-speed steel is used in an Armstrong toolholder when the space of the thread does not exceed the width of the tool.

It may be of interest to some of the readers of MACHINERY to know that the hand taps made in our shop are not made exactly to the standard formula, but the outside diameter is made with the following allowances:

Outside diameter, up to 1 inch diameter = nominal diameter + 0.005 inch.

Outside diameter, from 1 to 1½ inch diameter = nominal diameter + 0.007 inch.

Outside diameter, from 1½ inch diameter and over = nominal diameter + 0.010 inch.

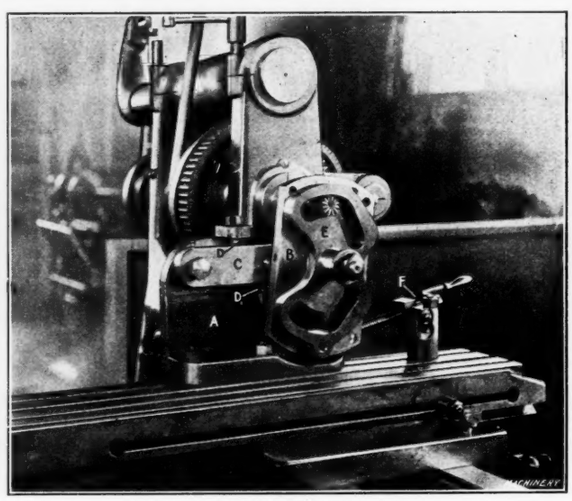
The length of the flute is 2½ inches in all cases. This applies to hand taps only.

* * *

SHIFTER CAM MILLING ATTACHMENT

The cams used on metal planers for shifting the belts require to be accurately formed and smoothly finished. The accompanying illustration shows a simple milling attachment used by the Cleveland Planer Works, Cleveland, Ohio, for milling out the slots.

The attachment consists of an angle-plate *A* on which is mounted a master cam *B* pivoted in the center. The master cam is not mounted directly on the angle-plate, but on a horizontal piece *C* which has a limited up-and-down motion. This



Belt Shifter Cam Milling Attachment

piece is held in a horizontal position by two short coil springs, *D* and D_1, oppositely placed.

The cam to be milled is mounted on the master cam-plate, as shown at *E* in the illustration, and an end milling cutter having a shank that closely fits the slot in the cam-plate is placed in the spindle. The slot is milled with a horizontal feed of the machine until the curve is reached, when its feed is thrown out. The cam-plate is then rotated by hand by means of the screw and handle *F*, shown at the right. When the curve has been traversed, the horizontal feed is again thrown in and the cutter traversed to the end of the slot.

This simple attachment is found valuable. It insures accuracy of the slots, interchangeability, and saves the time of a first-class mechanic filing out the slots by hand. A boy runs the machine carrying the attachment successfully, and produces work superior to that turned out by a mechanic at the vise.

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NOVEL USE OF RETOUCHED MACHINERY PHOTOGRAPHS

Manufacturers that issue illustrated catalogues and circulars accumulate retouched photographs and wash drawings that represent many dollars' investment. They are usually kept carefully stored away where no one sees them except when they are resurrected for use in making new illustrations. That machinery photographs and drawings can be put to other good use is shown in the illustration which shows how the Kearney & Trecker Co., Milwaukee, Wis., utilizes the retouched photographs of its "Milwaukee" milling machines and details of the same. The photographs, large and small, are mounted under mats and glass in oak panels on the four walls of the the president's and secretary's office. In this form the photographs make an effective and pleasing ornament to the office. The large photographs show details of the machines advantageously, and can be studied more easily than if they were loose or in an ordinary portfolio, and the color effects make them more attractive than ordinary catalogue illustrations.

Novel Use of Retouched Machinery Photographs in Kearney & Trecker Co.'s Office

The frames of the panels are of oak, the same as the desks and furniture. Each top and bottom strip of the sections is in one piece and is screwed to the wall, as are the vertical division strips between them. The panes of glass are independently mounted so that changes can be made in any section without disturbing the others. Ordinary picture mats are used with holes cut through of the size of the photograph that is to be shown. Back of the mats and photographs is placed a layer of ordinary corrugated backing which holds the glass against the molding.

The arrangement of the panels and pictures extends all the way around the office with breaks for doors and windows only, and the whole makes a most effective feature, which in this case partially solves the problem of properly taking care of retouched photographs and using them to good advantage.

TAPS AND TAPPING*†

The average user of machine screws and bolts may hear little about the theories and other details relating to tap- and die-making, but he must be interested, nevertheless, in being able to buy or make screws and bolts which can be depended upon to fit the tapped holes in the product he is making. There must always be a difference in dimensions of the screws and the tapped holes in order to make up for unavoidable imperfections in manufacture and for wear of the taps, and also to allow sufficient freedom of fit. The difference, however, should be confined to such limits that the smallest permissible diameter for the tap should be but slightly larger than the largest permissible diameter of the screw. If the limits are too large, a screw which happens to be used in a hole tapped by a maximum size tap would be too loose; again, if the limits are too small, interchangeability when assembling would be impossible, and the taps would not allow a reasonable amount of wear.

The two most vital factors are the size and the lead. In order to talk intelligently about the size, we must understand how a tap is measured. The fit of any screw should be on the sides of the angle of the thread, as the outside and root diameter have comparatively little to do with the actual fit. Unless the angle and the lead of the threads are the same in both screw and tapped hole, and the diameters measured across the angle of the threads are relatively right, a proper fit cannot be obtained.

In Fig. 1 is shown the effect of having nuts and screws of

* Abstract of a paper by Mr. F. O. Wells, read before the American Society of Mechanical Engineers, March 12, 1912.

† See also the following articles on this and kindred subjects previously published in MACHINERY. "Hook-fluted Taps," October, 1911; "Taps and Tapping," June, 1911, and the articles there referred to; "Rules for Threading Square Thread Taps," and "Making Hand Taps in Sets," May 1911, engineering edition; "Rapid Nut Tapping," April, 1911; "Dimensions of Bit-brace Taps," March, 1909; "Power Required for Tapping," June, 1909; "Power Tapping," February, 1909.

different angles of threads fitted together. In this case the screw is shown with a more obtuse angle than the nut, and the bearing between them will be on the sharp, fragile apexes of the teeth. The necessity of measuring correctly in the angle of the thread has led to the adoption of the term "pitch diameter" for screw threads, the same as for gears. In Fig. 2 is shown a micrometer for measuring the pitch or angle diameter. The merit of this tool is that it is not rendered inaccurate by the helix angle of the thread. It will, therefore, measure the finest lead as well as the coarsest within its range.

Fig. 3 shows how variation in the lead will affect the fit between the screw and the nut. The angle in this case is assumed to be correct, but the nut has been tapped with a tap having a long or stretched lead, with the result that at the base there will be a bearing on two threads only, as indicated at *A*, *B*, *C* and *D*. This is not an unusual condition, and explains why a nut tapped with a large enough tap will often start freely on a screw, turn a few turns and then bind. This also places all the strain on one tooth at a time, making it possible, with a sufficient longitudinal strain, to strip one tooth after another with a shearing action.

The difficulties due to variations in the sizes of screws and taps are well known to those who have to use them. For this reason many are using limit gages which are made especially to measure the screw diameters across the angle, and thus insure uniformity, within working limits, of the screws to be

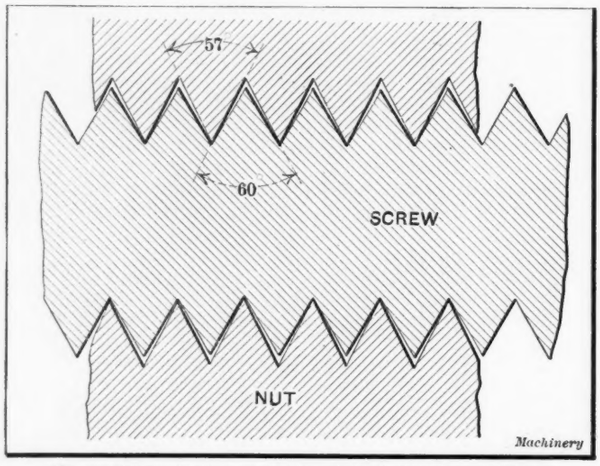


Fig. 1. Effect of Difference in Thread Angle of Nuts and Screws

used. Figs. 4 and 5 show one of these gages in use. The screw being measured has just passed the "go" or maximum limit in Fig. 4 and with the same movement of the hand is carried down to the "not go" or minimum limit, as indicated in Fig. 5. The rapidity and accuracy of this method of gaging is apparent. An inspector can pass on seven hundred and fifty ¼-inch taps per hour, both as regards angle and outside diameter, using, of course, two limit gages of this style. For ordinary screw work requiring less accuracy, he could pass on even a greater number.

As regards the lead of taps, it must be remembered that all steel will change somewhat in length in hardening; hence the lead of taps will vary somewhat from the standard. If in addition to this the hardened tap is warped on the threaded end, the condition of the tapped hole will be as indicated in Fig. 6.

We have now seen the effects that errors in lead, angle, angle diameter and warping in hardening will have on the taps. Add to this the effect of usage, reducing the size of the tap by wear, and then add the commercial variation in the lead, angle and diameter in screws and bolts, and it will be readily seen that under the best possible conditions, there will be a multiplicity of minute errors that must be taken care of by an allowance between the minimum limit of the tap and the maximum limit of the screw. There must also be a maximum limit for the tap and minimum limit for the screw in order to prevent too much looseness in the fit of the threads. There is at the present time a great diversity of opinion among tap and die makers, as well as among screw makers in general, as to what these allowances should be for the regular U. S. standard sizes, and hence the buyer of taps and screws is working under a serious difficulty in his efforts to obtain proper fits and interchangeable work. The standard adopted by the American Society of Mechanical Engineers for machine screws has been of great value, but the question of limits for the larger sizes of screw threads is still unsettled.

When a tap breaks or anything goes wrong in connection

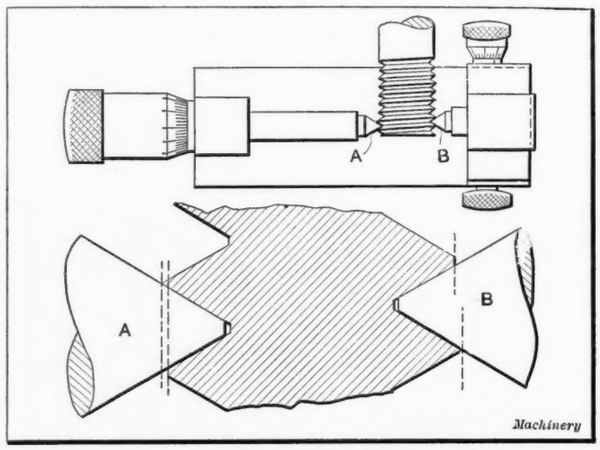


Fig. 2. Device for Measuring Angle Diameter, and Enlarged View showing its Application

with its work, it is probably the most natural thing in the world to blame the tap maker. In many cases, however, the trouble is due entirely to the condition under which the tap is working. In order to determine some of the practical questions in this connection, such as the proper sizes of tap drills, the best lubricants, the correct cutting angles and shapes of the flutes, the right number of threads among which the cutting should be distributed, the best method of hardening to increase the life and strength of the taps and to prevent undue distortion and shrinkage, the proper way to grind cutting edges, etc., the Wells Bros. Co., of Greenfield, Mass., built special testing machines showing the power required to drive any tap. A record of the cutting action was taken on indicator cards or charts.

Tap manufacturers often find that users of taps actually punch or drill the holes to be tapped of a smaller diameter than the root diameter of the thread, so that the end of the

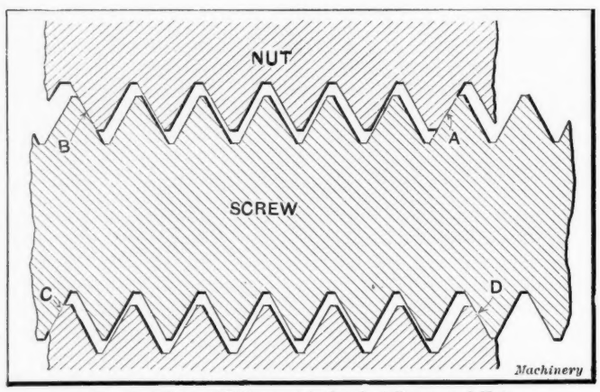
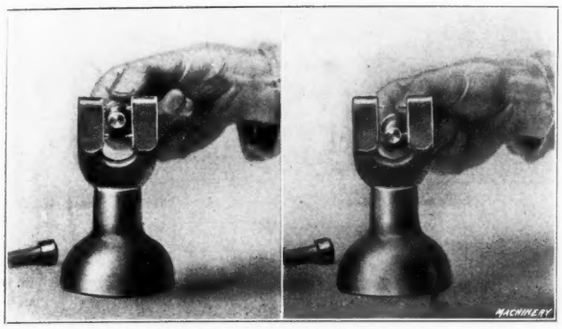


Fig. 3. Effect of Difference in Lead of Screw and Nut

tap must act as a reamer before the thread can be cut. In Fig. 7 are shown sections of such nuts through which taps have passed. In this case the tap becomes a taper reamer, reaming a tapering entrance to the hole, as shown in the nuts at the top. Frequently the tap will refuse to "catch the thread" at all and will ream clear through the nut. Should the thread happen to "catch" after reaming part way, however, a short, weak thread results, as indicated by the two nuts at the right in the lower part of the illustration. This condition evidently requires considerable power, and explains why taps frequently break as soon as they begin to cut. When it is remembered that generally not more than 80 per cent of the

standard thread depth is necessary in ordinary manufacturing work, and that in many cases not more than 50 per cent is required, it is apparent how useless it is to have the holes too small, and, in most cases, to even attempt to secure a full thread.

Tap drill sizes for machine screws, in particular, should be varied according to the material to be tapped and the depth of the tapped hole. In general, for holes where the screws enter more than one and one-half times the diameter, one-half of the full thread is usually sufficient. Soft, tough materials, such as copper, Norway iron, drawn aluminum, etc., should have a larger hole for the tap than the hard, crystalline materials, such as cast metals. The reason for this is that otherwise the taps of the threads of the softer materials will



Figs. 4 and 5. Limit Gage for Screw-thread Diameters, and its Use

be torn off, thus actually decreasing the effective depth of the thread of the tapped hole as compared to what it would be had the hole originally been drilled larger. On the other hand, if the hole is originally drilled large, the tap will, when cutting tenacious materials, especially after the keen edge has been slightly dulled by use, reduce the size of the hole by drawing the metal at the top of the thread, thereby increasing

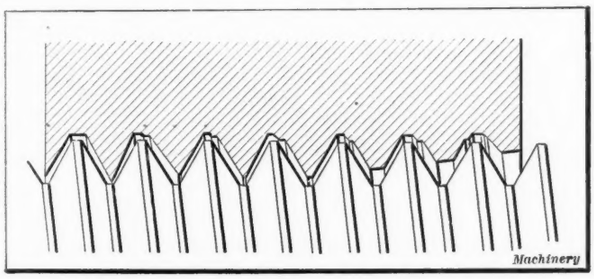


Fig. 6. Thread resulting from Tapping with a Warped Tap

the depth of the threads. It should also be remembered that it is impracticable to tap a hole with the basic root diameter size, unless serial taps or taps with long steps are used, so as to divide the work into a series of successive operations.

The size of the hole also affects very materially the power required for tapping. This is particularly important in machine tapping. The power is also affected by the kind of lubricant

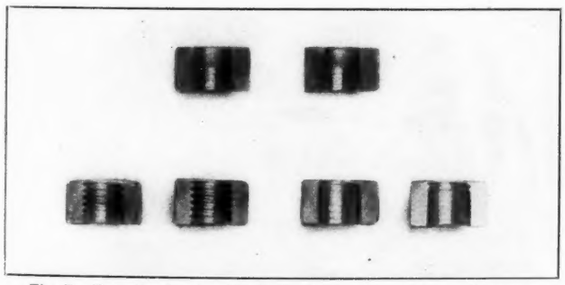


Fig. 7. Nuts, having too Small Tap Holes, reamed by End of Tap

used, by the condition of the tap as regards being sharp or dull, by the shape of the cutting edges and their effect on the shape of the chip, and by the shape of the flutes. In Fig. 8 are shown three taps with different kinds of flutes. The tap in the middle (having what is called a "hook" flute) produces a long, curling chip which in a deep hole will have sufficient length to curl up tightly, jam the tap and cause it to break off if there is sufficient driving power. The chips from this tap are shown in Fig. 9. In Fig. 10 are shown two nuts in which these long curled chips have rolled up and broken the tap. The end of the broken tap is also shown.

The tap shown to the right in Fig. 8 does not cut properly, but pushes the metal ahead of it, often accumulating so much compressed metal as to resist further compression, which

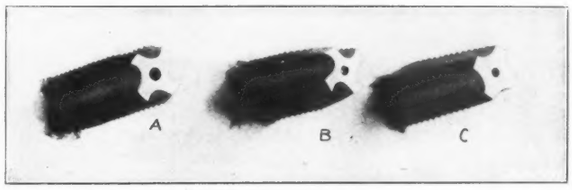


Fig. 8. Taps with Different Flutes having Different Cutting Action

causes the tap to break. This tap broke while tapping cold punched nuts, twisting off near the shank at a strain of 1100 inch-pounds. The work was divided between 48 cutting teeth. The chips made by this tap are shown in Fig. 12. They are compressed in character and show by their appearance the relatively large amount of power required for tapping. In Fig. 13 are shown sections of four nuts tapped with the type of taps mentioned, and which broke while being tapped.

Fig. 9. Chips produced by Tap B, Fig. 8

The compressed mass of metal still adhering to the thread should be noted.

The tap shown to the left in Fig. 8 is properly made. It produces a slightly curling chip, which breaks up into short lengths and easily slides out through the flutes. This tap requires only about one-third of the power of the tap to the right. The chips cut by this tap are shown in Fig. 14. Fig. 11 shows a section of a nut in which this last style of tap was

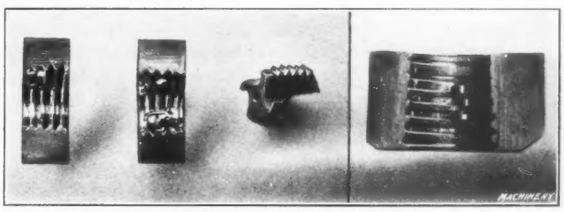


Fig. 10. Nut tapped by Tap B, Fig. 8, and Part of Broken Tap

Fig. 11. Nut tapped by Tap A, Fig. 8

started, and the nut was then cut open to show the action of the chip. The smooth thread and the clean, short chips just at the point of breaking should be noted.

As almost all machine tapping is in through-holes, and bottoming taps are seldom used, experiments have been made to determine the effects of sharpening or grinding the taps back from the end for a varying number of threads, so as to ascertain the effect of dividing the work between a greater or smaller number of cutting teeth. By repeated tests and careful records it has been found that it requires approximately 25 per cent more power to drive a tap which has been ground back only four threads (which in a four-fluted tap divides the work between 16 teeth) than for one which has been ground back six threads (thus having 24 cutting teeth); the latter

tap produced a much smoother thread and cut more closely to size.

Chattering in tapping is often due to burrs thrown up on the cutting edges of the tap during its manufacture, and it is very necessary that the taps be free from burrs. Considerable attention should be paid to this point in order to produce good taps.

TABLE I. POWER IN INCH-POUNDS, REQUIRED FOR TAPPING VARIOUS MATERIALS

Taps, ½ inch, U. S. S. Tap drill hole, 0.420 inch. Depth of tapped hole, ½ inch

Material	Test Numbers of Taps													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hexagon drawn brass	60	62	62	60	65	70	60	90	60	60	60	60	60	65
	65	60	65	60	65	80	60	95	62	60	60	62	65	65
Crucible tool steel	220	242	250	230	240	280	250	375	210	270	260	270	260	258
	225	265	268	250	230	260	235	380	205	280	275	260	260	270
Cold punched hexagon steel nuts	148	158	168	170	155	150	150	340	165	195	165	175	148	180
	130	130	175	190	160	180	132	360	140	160	225	200	180	180
Hexagon screw stock	140	150	165	188	178	180	155	250	140	240	235	168	225	230
	160	170	185	165	210	268	170	430	155	190	200	160	205	205
Drawn hexagon phosphor-bronze	210	175	250	200	230	240	170	338	160	200	220	222	265	210
	190	200	300	250	200	250	182	320	190	330	210	245	205	210

TABLE II. EFFECT OF VARIOUS LUBRICANTS AND DIFFERENT DIAMETERS OF TAP DRILL HOLE

By multiplying the percentages given by 10, the actual average power required for tapping in inch-pounds, may be obtained.

	Lubricant	Animal Lard Oil	Sperm Oil	Graphite, 10 per cent; Tallow, 90 per cent	Cataract Soap Compound	Mineral Lard Oil	None (Tapping Dry)	Machine Oil
0.425 Diam. Tap Hole (75 % Thread)	Power required*...	15.9	16.5	16.9	18.9	19.9	29.9	34.2
	Breakages in tests†.	None	None	None	None	None	14	15
	Quality of thread..	Smooth	Smooth	Smooth	Smooth	Smooth	Rough	Torn
0.410 Diam. Tap Hole (90 % Thread)	Power required*...	....	23	....	25.1	36.5	60.2	62.5
	Breakages in tests†.	....	None	....	None	None	50	71.5
	Quality of thread..	....	Smooth	....	Smooth	Smooth	Rough	Badly torn
0.400 Diam. Tap Hole (Full Thread)	Power required*...	....	35.5	....	41	57.5	71.8	100
	Breakages in tests†.	....	None	....	None	None	66	100
	Quality of thread..	....	Smooth. Taps torn	....	Slightly Rough, Taps torn	Smooth, Taps torn	Torn, partly stripped	Torn, Chips wedged

* In per cent of breaking strength of tap. † In per cent.

The power required for tapping different materials is shown in Table I. This table gives the results found from tapping five different materials with fourteen different taps. The maximum and minimum power required by each tap when tapping consecutive test pieces is given in inch-pounds. The taps Nos. 6 and 8 had a slightly poorer form of flute than the rest and did not cut as smoothly nor as easily. Table II shows the effects of variations in the tap drill sizes as well as the effect of different lubricants. In this chart, which is the final result of a long series of tests, it is assumed, for comparative purposes, that the breaking strength is 100, and the strain produced by tapping holes under different conditions is given as a percentage of this. The power required to break a properly made ½-inch, 13 threads per inch, U. S. S. tap, is approximately 1000 inch-pounds; hence by multiplying the percentage given in the table by 10, the actual average power required, in inch-pounds, may be obtained. The test pieces were common hexagon cold punched nuts, accurately reamed to the respective sizes of holes, the taps being regular taps taken from the stock-room.

The points brought out by this series of tests were:

1.—The lubricants used, up to a certain point, have the same effect on the power required for cutting as if more or less metal were to be removed; for instance, to tap a one-half inch nut having a hole of 0.425 inch diameter, using machine oil instead of sperm oil, would have practically the same effect on the power required as if the diameter of the hole to be tapped were reduced 25 per cent of the total depth of the thread. It will be seen in the table that the power is approximately doubled in both cases. When changing from sperm oil, the increase is from 16.5 per cent to 34.2 per cent while when changing from 0.425 inch to 0.400 inch tap drill the increase is from 16.5 per cent to 35.5 per cent.

2.—Animal lard oil, sperm oil, and graphite and tallow mixture are the best lubricants of those tested.

3.—A good soap compound is better than mineral lard oil for tapping.

4.—Machine oil is a detriment instead of an advantage. Taps cut better dry than with this lubricant.

5.—The breakage of taps is greatly reduced by the using of a proper lubricant. Taps should never be used without a lubricant when tapping steel.

6.—The diameter of the tap drill hole should not be smaller than is absolutely necessary to give the required strength. If for any particular purpose the full depth of the thread is required, it would be advisable from a tapping standpoint to gain strength by using a larger size thread instead.

7.—If for any reason it is necessary to produce a thread of full depth, serial taps should be used, with the best lubricant obtainable.

Fig. 12. Chips produced by Tap C, Fig. 8

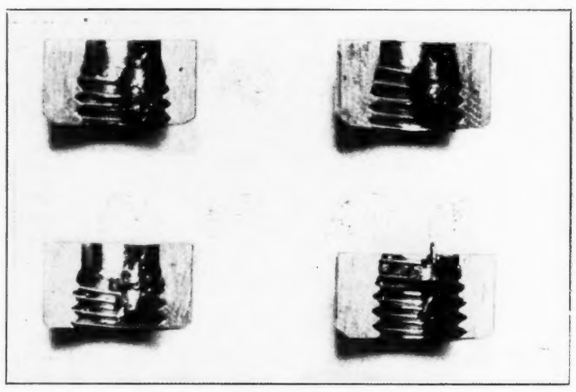


Fig. 13. Nuts tapped by Tap C, Fig. 8

8.—Every decrease of even one-thousandth inch in the diameter of the tap drill hole materially increases the power required for tapping and also the percentage of broken taps.

Referring to the sperm oil column in Table II, it will be

seen that the decrease of 0.015 inch in diameter from 0.425 to 0.410 inch, required only 6.5 per cent additional power, or 65 additional inch-pounds. This is an average of a little over 4 inch-pounds per 0.001 inch. A decrease in the tap-hole size of 0.010 inch, from 0.410 to 0.400 inch, required 125 additional inch-pounds of power, or an average of 12.5 inch-pounds per each thousandth inch.

Discussion of the Paper

In the discussion that followed the reading of the paper abstracted in the foregoing, several interesting points relating to the inspection and use of taps were brought out. Mr. A. A. Fuller spoke of the relation between errors in lead and angle diameter, and presented diagrams showing how limits can be established that take into account the combined effect of these errors. The principle involved was the same as that explained in MACHINERY, July, 1907, in an article entitled "Remarks on the Making of Hand Taps," but Mr. Fuller's method was a refinement of this, and the definite limits established were indicated. It was pointed out that the shorter the hole, the greater could be the allowable error in the lead; but as it is more difficult to tap a long hole with a minimum error than a short hole, it is best, in practice, to adhere to an allowable error per inch in the lead and to compensate for that error by varying the angle diameter. The increase in diameter, for one inch depth of hole and 60-degree thread, should equal the error in lead divided by 0.58. If the depth of the hole is less or more than one inch, it is only necessary to correct the

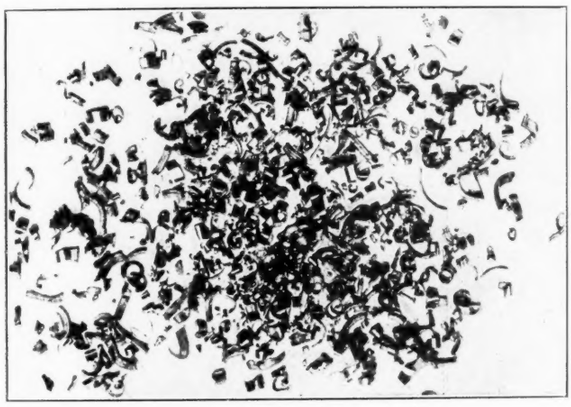


Fig. 14. Chips Produced by Tap A, Fig. 8

diameter in proportion. The error in lead, however, is more objectionable than the error in angle diameter, on account of the lack of bearing which the former produces.

Mr. L. D. Burlingame presented a paper the object of which was to arouse the engineering societies and the manufacturers to the needs for a fine screw thread standard with U. S. S. threads, similar to that adopted by the Engineering Standards Committee of Great Britain, for Whitworth screw threads. (See MACHINERY, October, 1906, "British Standard Fine Screw Thread.") A comparative table of different screw thread standards was also presented. Mr. George W. Adams called attention to the need of education among foremen and machinists relative to the measuring of screw and tap threads. He thought that the tap manufacturers could do a great deal in this respect by giving a greater amount of useful information in their catalogues, and he said that he believed that they would find it to their own advantage to do so, as it would lessen the number of complaints of their products, many of which are due simply to ignorance on the part of the user.

Mr. C. B. Russell stated that in order to determine the progress of the adoption of the U. S. standard thread as compared with the sharp V-thread, he had looked up the sales of the Wiley & Russell Mfg. Co., Greenfield, Mass., and had found that 93 per cent of all tapper taps sold were of U. S. standard, as compared with 7 per cent of the V-form. Of hand taps, however, 50 per cent are still of the V-form.

With respect to lubrication, Mr. J. E. Winter mentioned that in threading steel pipe, cottonseed oil gives even better results than lard oil. The only objection to this oil is that it tends to "gum up" the machines, but it can easily be cleaned off by kerosene oil. Cottonseed oil is much cheaper than lard oil. Mr. G. Pickop mentioned that grape-seed oil has about the same efficiency as lard oil, and is extensively used as a threading lubricant.

Mr. F. O. Wells stated that when new an ordinary commercial tap has an average factor of safety of 2. He also called attention to the influence of lubrication on the size of the hole tapped or screw cut. If a screw is cut with a die using lard oil as a lubricant, the size sometimes will be from 0.007 to 0.008 inch smaller than when a soap compound is used as the lubricant.

* * *

DON'TS FOR GEAR-HOBBERS

By A. E. BOWYER-LOWE*

Don't forget to keep your hobs sharp.

Don't forget to put the key in the hob.

Don't forget to put the covers on the gears.

Don't start the cut before the pump is working.

Don't expect a fine finish if you crowd the feed.

Don't mesh the dividing or feed gears in too tightly.

Don't forget to give the table-driving worm plenty of oil.

Don't forget to pack up the blank on as large a diameter as possible.

Don't bush a large gear to fit a small mandrel; make a large mandrel.

Don't forget to see that the blank runs true before you start cutting.

Don't try to cut a spiral gear without first keying the job to the mandrel.

Don't forget to pull the machine around by hand before starting a new job.

Don't take the numbers stamped on the change gears for granted; count the teeth.

Don't try to hob a wormwheel, without first clamping the hob carriage to the column.

Don't forget to look now and again at the wire rope holding the hob carriage balance weight.

Don't omit to center a tooth of the hob; it doesn't take long, and if it does no good it certainly does no harm.

Don't try to hob steep angle spirals without knocking off the partial teeth at the leading end of the hob.

Don't forget to use both ends of the hob, in addition to the center; it saves a lot of grinding, and the hobs last longer.

Don't set the feed knock-off when hobbing spiral gears, without being at hand to stop the machine as soon as it operates.

* * *

As an example of the effect upon production, and the consequent financial results, of the use of automatic machinery, under efficient management, I cannot refrain from mentioning the Singer Sewing Machine Co., where I have reason to believe that the application of automatic machinery has reached one of the highest marks in this country. It is a recognized fact that automatic machinery, under efficient management, has been the chief cause of the tremendous financial success of this company. The original investment of this company was only $600,000. It has declared a stock dividend of $75,000,000. It has paid $440,000,000 in dividends to its stockholders, and is now paying 12 per cent dividends on a capitalization of $100,000,000. The figures are those of Mr. Robert Hearne in a statement before the Senate finance committee on the Underwood steel bill at a hearing in Washington a couple of weeks ago. Mr. Hearne also claimed in this connection that in spite of the fact that labor is about 40 per cent cheaper in Europe than in the United States, sewing machines can be and are manufactured cheaper in the United States than abroad, a fact which can be attributed largely to the use of automatic machinery, superiority of American workmanship and that American labor is more experienced and better equipped. As a proof of his statement, he pointed to the fact that the United States exports annually $9,000,000 worth of sewing machines, meeting foreign competition in its home markets.—*From an address by A. L. Valentine on "Comparison Between Industrial Conditions in the United States and Europe," before the American Society of Swedish Engineers.*

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THE CARE AND REPAIR OF HYDRAULIC JACKS*

By ARTHUR J. HUMPHREY†

Many mechanics who use hydraulic jacks are unfamiliar with their construction and the methods employed in the repairing of them. Hydraulic jacks are manufactured in a variety of types and sizes, but they are all fundamentally of the same construction. For the purpose of illustration in this article, I have selected a vertical single inside pumping type of jack. More recent types of jacks are on the market, some having double pumps for light or heavy duty, but there are probably in use to-day more jacks of the type chosen than of any

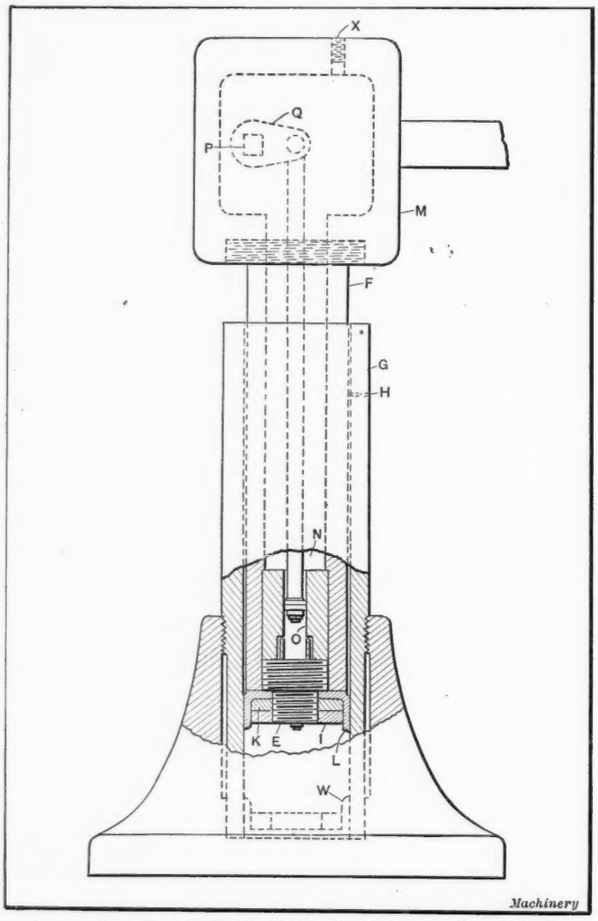

Fig. 1. Elevation of a Vertical Single Inside Pumping Type of Jack

other, and as the principle upon which all types of jacks work is the same, the following description will apply generally.

In the type of hydraulic jack illustrated in Fig. 1, the head and interior tube or ram form a reservoir in which the liquid flows to the pump. From the pump the liquid is forced by the downward stroke of the piston past the lower valve into the cylinder, and as the latter is closed at the bottom, the ram rises to allow space for the liquid. When lowering, the lower valve *A*, Fig. 2, is pressed from its seat by the end of the piston rod, and the liquid returns to the upper part of the jack by passing around the piston through small port-holes *B*.

To illustrate the proper procedure to follow in repairing a hydraulic jack, suppose that a jack has been reported as failing to work. Now the jack may fail in a number of ways and from various reasons, and the nature of the failure may indicate the location of the trouble and how to remedy it. For instance, there may not be any liquid in the jack, in which case the jack will certainly not work. To remedy this, it is only necessary to fill the jack with liquid, provided it has not been emptied long enough to dry out the leather packing on piston and ram. If the jack raises the load, but will not lower it, the bottom valve *A* is probably too short, so that the piston when clear down will not force the valve from its seat. To remedy this a longer valve is inserted, or if there is no valve available and it is necessary to use the jack before one can be secured, a small amount of solder may be dropped on the end of the valve to lengthen it. However, this is not recommended, and should only be used as a makeshift.

If the jack lifts, but will not hold a load, it is evident that the liquid, after being forced into the cylinder, must be leaking out again. By observing the jack while under pressure, and noting whether the liquid leaks around the bottom or over the top of cylinder *G*, we can determine which particular packing leather needs renewing. If no leak appears at these points, the liquid must be slowly leaking to the top of the jack through the ram valve *A*, piston valve *C* or around the piston packing *D*.

The valve seats and piston packing if only slightly cut will allow a light load to be raised quickly, but as the liquid leaks out the ram will slowly drop down again. Of course, if the seats are cut considerably, the jacks will not raise or lower at all. It is sometimes found that pieces of grit or dirt lodge on the valve seats, or the valves stick to their seats and prevent the jack from working. By giving the jack lever a firm quick jerk up and down, the dirt may be dislodged and the valve released. If when pumping or under pressure the lever rises

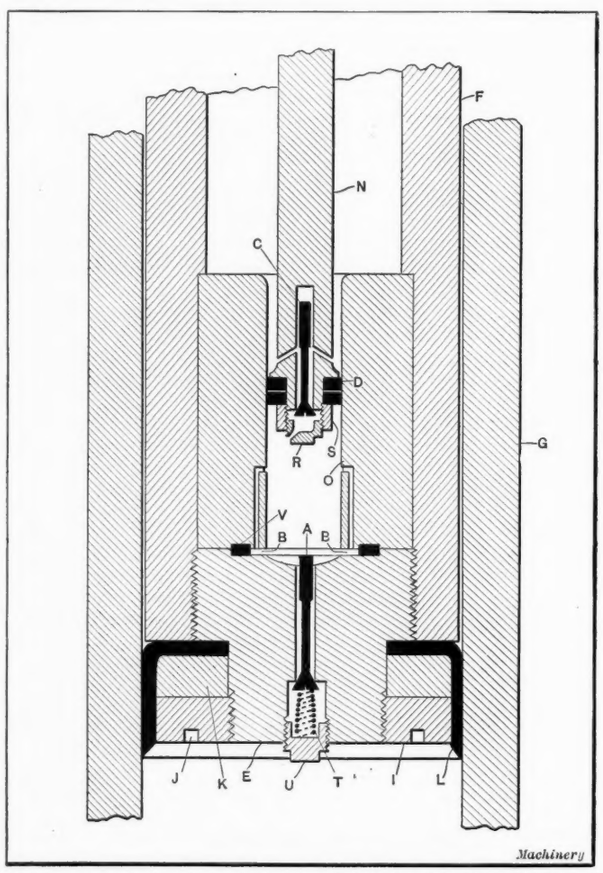

Fig. 2. View of the Principal Working Parts of the Jack shown in Fig. 1

when the hand is removed, there is something under the ram valve *A*, or the seat is cut so that the liquid returning through the pump plug *E* communicates pressure to the piston, raising it to the top of its stroke. Probably the most common jack failure is that of not raising the load due to leakage in the valves or looseness in the pump packing. Assuming that such is the case and that it is necessary to overhaul the jack, proceed as follows:

Referring to Fig. 1, remove the ram *F* from the cylinder *G* by pumping it up as far as possible and lifting it out of the cylinder. If the ram is too heavy, or the packing too tight to permit this, the ram may be entirely removed by driving a wooden plug into the small vent hole *H* in the side of the

* For additional information on hydraulic jacks and kindred subjects, see the following articles previously published in MACHINERY: "Dudgeon 'Universal' Hydraulic Jack," March, 1910; "Notes on the Manufacture of Hydraulic Machinery Gathered in the Shops of the Watson-Stillman Co.," October, 1899.

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cylinder. This vent hole limits the travel of the ram, so that when it is plugged and sufficient water is poured into the reservoir to entirely fill the cylinder, the ram can be removed. If it should so happen that the ram cannot be pumped out, it may be necessary to pull it out with a crane, or force it out with a long lever. The jack lever should be pressed down before attempting to do this.

Let the liquid stay in the jack cylinder for the present, and grip the ram in a vise, taking care not to mar it. Unscrew the nut *I* (see Fig. 2) with a spanner fitting in the holes *J* and remove the ring *K* and the ram packing *L*. Now unscrew from the ram the pump plug *E*, and the head *M*, Fig. 1. The pump piston *N* may now be withdrawn from the pump cylinder *O*. If it is desired to inspect the socket packing, this may be done by loosening the set-screw and withdrawing the socket *P* from the arm *Q*. To renew the packing, cut a washer from sole leather, making the inside of the diameter slightly smaller than the socket, and the outside diameter the same as the recess. After inserting the new packing washer, remove all small pieces of leather which have been cut off from the washer, then drive the socket in place again through the ram and tighten the set-screw.

To examine the pump cylinder *O* to see if it is cut, drive it out with a wooden plug. If the cylinder is badly worn it

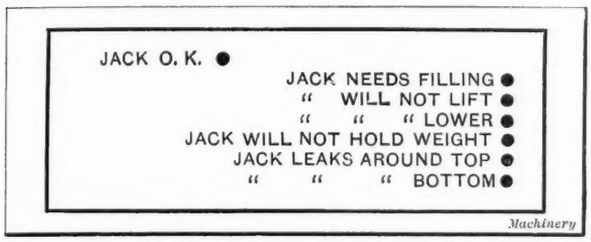


Fig. 3. Repair Report Nameplate fastened on Each Jack in Use

should be trued by reaming. Then force the cylinder over the piston and note if the piston packing is a tight fit in the cylinder. Sometimes it will be found that the piston packing is tight at the ends of the cylinder but quite loose in the middle, indicating that the cylinder has become worn where most of the travel is. If this is found to be the case, it is necessary to ream the cylinder and straighten it up, removing as little material as possible and using oil as a lubricant. After enlarging the cylinder, the piston packing must be renewed. To do this remove the brass valve bonnet *R*, piston packing ring *S*, piston packing *D* and valve *C*. Now insert a new packing leather washer on the piston, then a cup packing leather, with the cupped side facing bottom of jack; then screw up piston packing ring fairly tight, and fit the packing in the cylinder with a clean file.

Proceeding with the inspection, examine the valve *C* and its seat; the latter will usually be found to be all right, but if the seat is deeply cut, it should be "reset," with a set having an included angle the same as that on the valve. If the valve is much worn a new one should be put in. An old valve may be fitted, by carefully filing and then grinding it into the seat with oil and flour emery. If the ram packing *L* has become worn and the liquid has been leaking over the top of the cylinder or through the vent hole, place a strip of thin tin around ring *K*. After ascertaining that all the port holes, etc., are free from dirt and grit, assemble the ram by replacing the head, piston and then the cylinder. Before replacing the pump plug *E*, inspect the leather washer *V* to see that it makes a tight joint between the plug and cylinder. If it does not fit tightly, a new one should be inserted. Examine valve *A* and its seat and grind them if necessary. After the plug *E* is in place, the valve *A* should be inserted and tested, to see whether it will release the jack or not. To ascertain this, press the valve to the seat and force the piston down to the bottom of the cylinder, at the same time observing if the valve is pressed from its seat—a space of ⅛ inch is sufficient; then replace spring *T*, bonnet *U*, ram packing *L*, ring *K* and nut *I*, and empty the liquid from the cylinder *G*.

The bottom packing *W*, Fig. 1, seldom gives trouble, but if it should become necessary to renew it, remove the old packing and drive the new packing and ring in from the upper end of the cylinder by means of a wooden plug, which is slightly smaller than the cylinder bore. If the cylinder is badly cut and it is impossible to renew it, it can be repaired by reboring it and then forcing in a cold-drawn tube lining of the proper size.

After washing out the cylinder, wipe and oil it and then insert the ram. A handy appliance to assist in starting the packing into the cylinder, is a clamp made of thin sheet iron. This clamp encircles the packing and the ends are turned outward to receive a small bolt for tightening it. After pressing the jack lever down in order to open the valve so that the air may escape, push the ram down and strain the liquid into the jack through the filling and air plug *X*. The liquid recommended for use in hydraulic jacks is as follows: To one part of grain alcohol add two parts of water. This liquid is probably the best as it does not freeze in cold weather, corrode the pump, gum and clog the valve, and has not a deteriorating effect on the leather packing. Never fill a jack without straining the liquid.

After a jack has been overhauled, it is advisable to put it under pressure and let it remain so for a few hours. This will test the jack and set up the packing. If the jack has been fitted with new packing, it is well to let it remain over night before using it in order that the leather may be thoroughly soaked. If the repair has been handled in the proper manner the jack will give good service. It is essential, however, to keep it in good order, and without this precaution it is useless to expect satisfactory service from it. Most of the trouble met with in using hydraulic jacks is caused by neglect—allowing rust or foreign substances to collect, or broken and dried-up packing to remain; another precaution is not to overload the jack. The ram should be down when the jack is filled to prevent using more liquid than the reservoir will hold. If a jack is full when the ram is run out, and the cylinder under the ram is also full, it would be possible to burst the reservoir if the ram was lowered while under load and the air-hole in the reservoir had become plugged.

Always keep the ram quite down within the cylinder when not in use, otherwise the piston and ram packing may be out of the water and so become dry. For the same reason do not jack a load up to the full extent and let it remain so for several days, rather block under the load and remove the jack. Do not push the operating lever down too quickly, nor check the lowering of the load suddenly, especially under a heavy load. The sudden checking of a heavy load traveling at a high momentum, is likely to swell the cylinder to a permanent set, which will ruin it. To lower the weight, push the lever to the bottom of the stroke, then take it out and turn it with the projection upward, and with a slight pressure of the hand, the weight may be lowered as slowly as required and stopped at any point.

In large shops and round-houses where a number of hydraulic jacks are in constant use, the repairs may be made much more quickly by adopting the following system: A brass plate, Fig. 3, similar to a nameplate is attached to each jack, say on the outside of the cylinder, and a number of small holes drilled and tapped as shown, and provided with a thumb-screw to fit the hole. When the jack is sent in for immediate repair, whoever has condemned the jack, should remove the screw from the hole opposite "Jack O. K." and place it in the proper hole, designating why the jack has been sent in for repairs. Each jack is numbered and a record is kept by the man in charge of repairs; then by noting in which hole of the plate the thumb-screw has been placed, and by referring to the record book to see what repairs were made in the past, it is possible to determine very quickly just what must be done to make the jack fit for service as soon as possible. After the jack is repaired, the thumb-screw is placed in the "Jack O. K." hole again. Of course a printed report blank or card sent in with the jack would answer the same purpose as this plate, but it is difficult to get the mechanics using the jack to take the time and trouble to fill out the blank, and the thumb-screw is much handier. The plate may be cast or cut out of sheet brass and stenciled, or a printed card may be pasted on it and covered with white shellac.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

NARROW VS. WIDE GUIDES FOR MACHINE TOOLS

In the January number of MACHINERY, Mr. J. S. Detrick, of the Detrick & Harvey Machine Co., explains why his firm has adopted the narrow guide for machine tools in preference to the wide, and gives the readers to understand that by reducing the ratio between the length of the guide and the width it was found that cross-winding was considerably reduced.

Theoretical considerations of the problem indicate, however, that the width of the guide has no vital influence upon the amount of cross-winding which can take place, but that the length of the guide has. This is explained in the following treatment of the case. Let L = the length of the guide; B = the width of the guide; and db = the amount of play between the surfaces of the guide and those of the sliding part.

These conditions are indicated in the accompanying diagram in which the amount of slack or play is shown considerably exaggerated. The angle a is the angle of cross-winding of the sliding part on the guide, this angle being formed by the diagonal of the sliding part in two positions, namely, the intermediate or normal position and one of the extreme positions. Let

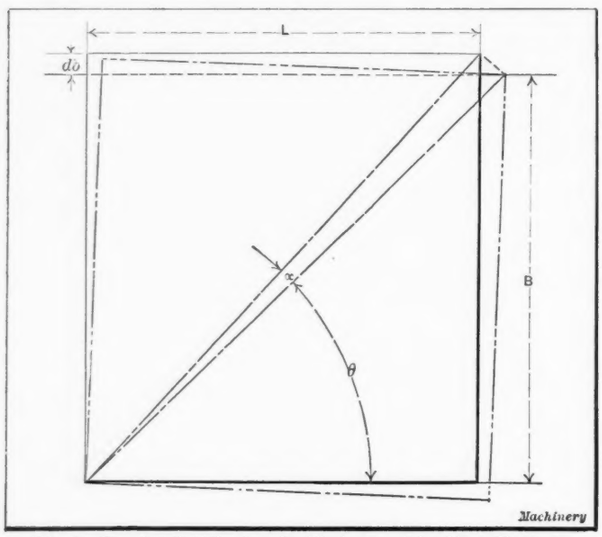


Fig. 1. Showing that the Angular Displacement for Given Clearance is nearly the Same on Wide and Narrow Guides

the length of this diagonal be denoted by x. Then, from an inspection of the diagram, it will be seen that

$$\frac{B + d\,b}{x} = \sin(\theta + a) = \sin a \cos\theta + \cos a \sin\theta$$

Now, $\sin\theta = \frac{B}{x}$; $\cos\theta = \frac{L}{x}$ (practically); $\sin a = a$ (practically) because a is very small; and $\cos a$ = unity for the same reason. Hence,

$$\frac{B}{x} + \frac{d\,b}{x} = a \times \frac{L}{x} + 1 \times \frac{B}{x}; \text{ therefore}$$

$$d\,b = a \times L, \text{ and}$$

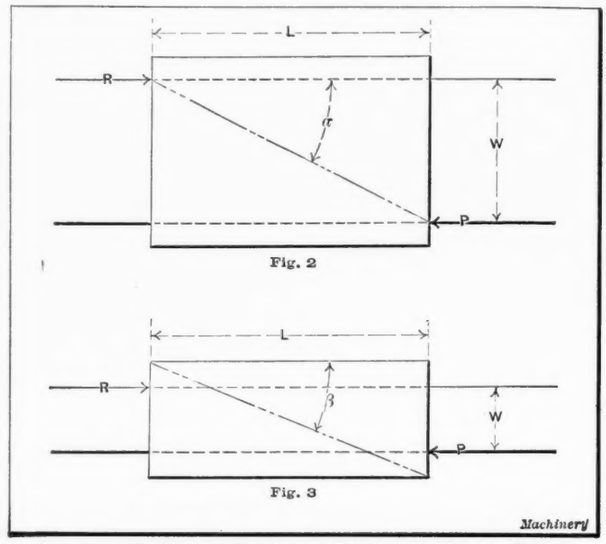
$$a = \frac{d\,b}{L} = \frac{\text{amount of slack}}{\text{length of guide}}$$

This shows that the amount of cross-winding is inversely proportional to the length of the guide or slide, always assuming, of course, that the amount of slack or play is a very small quantity, and that the width-dimension is not a factor in this connection.

This conclusion is opposed diametrically to the conclusion Mr. Detrick arrived at as the result of practical considerations, and it would be very difficult indeed to explain the difference between them. One explanation which has occurred to the present writer is that it is much easier to machine narrow guides which are reliable and parallel than it is to machine wide guides possessing the same qualities. This appears, however, to be a point which requires the results of a series of reliable experiments for its satisfactory elucidation.

Sheffield, England — GEORGE W. BURLEY

[Although it is true that the angle of deflection due to cross-winding is the same with wide and narrow guides, other conditions being the same, the lateral pressure on the sides of the guide and slide is greater on a wide guide than on a narrow guide for any given eccentric load. Referring to the diagram,



Figs. 2 and 3. Showing that Lateral Friction and Wear are Greater on Wide Guides than on Narrow Ones

Fig. 2, suppose an extreme case in which the pressure required to move the slide is applied at one corner directly over the edge of the guide and the resistance to movement is all at the diagonally opposite corner, as shown at P and R. Then the turning moment is $\frac{P \times W}{L} = P \tan a$. In the case of the narrow guide, Fig. 3, it is apparent that $P \tan \beta$ will be less than $P \tan a$. Hence the greater angle a is, the greater will be the lateral pressure, approaching infinity as W becomes very wide or L very short. Therefore friction and wear are greater on wide guides than narrow ones.—EDITOR.]

POWER REQUIRED TO DRIVE REAMERS

Recently we wrote to three manufacturers of reamers and one of our prominent colleges asking if they had ever made tests to determine the difference in power consumed as between three-groove spiral chucking reamers and four- or six-lip parallel reamers. None of them had made tests or knew of any results to which they could refer us.

With so much being written on efficiency and economy in manufacturing, is it not rather curious that there should be no data on this subject?

The writer has used both kinds of reamers, and knows there is a great difference in the amount of power required to drive these reamers. The feed and speed that can be used with spiral reamers is much greater than with parallel reamers and much less care is required for the belts. In fact we can almost feel safe in saying that the saving is fifty per cent. We can get all the data necessary as to rake, clearance, etc., on lathe or planer tools, also on drills. We can get the horsepower consumed driving these tools with these various clearances and angles, but who can tell us the difference in horsepower consumed as between three-groove spiral chucking reamers and four- to six-lip parallel reamers?

Auburn, N. Y. — A. A. BERTRAND

DEVICE FOR TESTING AND MEASURING GEARS

The device shown in Fig. 1 has been used for several years with very satisfactory results. Differences in diameter and eccentricity of 0.01 millimeter (0.00039 inch) can be measured by it, and the exact meshing of a couple of gears can be accurately tested. On the cast-iron base are fitted two slides, each being provided with a spindle to hold the gears to be tested. The slide to the right is moved by means of a long adjusting screw; the one to the left has only a very limited adjustment, but transfers its motion, greatly magnified, to an index placed on the front side of the base. Fig. 2 is a longitudinal section of the device; it clearly shows how the motion is transferred to the index, which measures the differences in eccentricity and the errors in mesh with great accuracy. To detect differences in eccentricity, it is most convenient to place the gear to be tested on one spindle, and to use a blank with a single tooth on the other. This tooth is meshed in succession with all the teeth of the gear under test, and by observing the different positions of the index while each tooth is measured, the eccentricity may be determined with great accuracy.

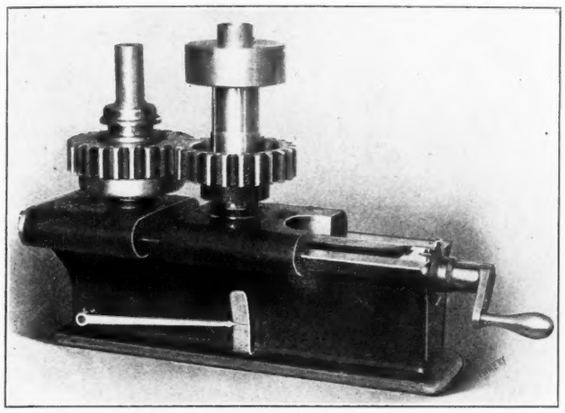


Fig. 1. Device for Testing Gears

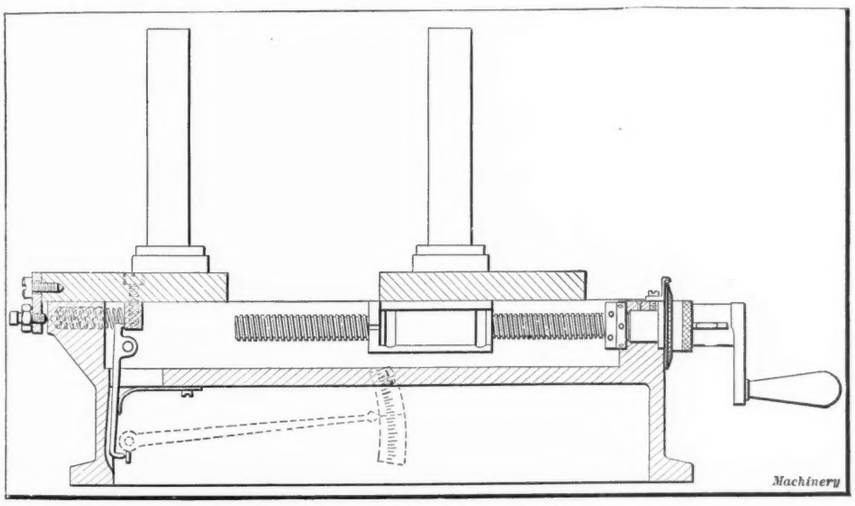


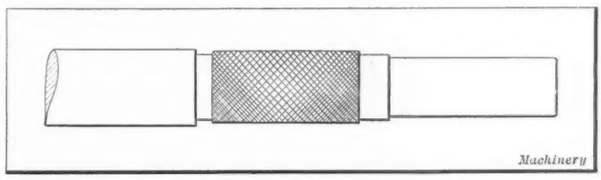
Fig. 2. Section of Device for Testing Gears

Torino, Italy. C. BOELLA

SAVING A SHAFT BY KNURLING

It has been common shop practice to condemn shafts, axles, etc., which have not met the allowance required for a press fit. This practice has made the manufacturer as well as the mechanic suffer for slight errors, and the junk dealer alone has profited. The manufacturers have lost thousands of dollars yearly due to small errors, such as shafts or axles being, for example, 0.0005 inch or 0.001 inch too small for the gears, pulleys, collars, flanges, etc., into which they are to go, or because commutator shells are from 0.0005 to 0.001 inch too large for a press fit.

Here is where the knurl plays a big role by rectifying even larger mistakes in a few minutes. Suppose that a commutator shell, pulley, or gear has accidentally been reamed or bored 0.001 or 0.005 inch too large. Instead of scrapping and duplicating these parts, put the shaft between the lathe centers, and knurl the seat for the press fit as shown.



Saving a Shaft by Knurling

The knurl should be coarse and can be straight, spiral or cross-cut, and of any size or width, although for a small shaft a narrow knurl is required. After knurling, the shaft will be about 0.020 inch larger, depending upon the coarseness of the knurl. After this operation the shaft can be turned down again to the press fit allowance. This simple operation will prove very satisfactory in any line of work where press or shrinkage fits are used. J. E. U.

MULTIPLE-THREAD INDEXING IN THE LATHE

The following formula will be found useful to any machinist or toolmaker. The writer has had occasion to cut multiple-thread worms or spiral gears in the lathe, and in not one instance has the operator been able to do the proper indexing. It is quite simple to index for a double or triple thread, but few average workmen know what to do when the number of threads is greater than that. Therefore the writer has formulated the following rule which will cover every case:

Multiply the number of threads per inch of the lead-screw of the lathe by the lead of the spiral to be cut, and multiply this product by the number of teeth in the gear on the lead-screw; then divide that product by the number of starts or teeth in the worm or spiral. The quotient is the number of teeth the lead-screw gear will have to be turned to give the proper indexing.

For example, we want to cut a spiral gear having 8 starts or teeth, with a lead of 1½ inch in a lathe having a lead-screw with 6 threads per inch. We first figure our gearing for the lead, which gives a gear having 24 teeth for the lead-screw. According to the rule, we then have $\frac{6 \times 1\frac{1}{2} \times 24}{8} = 27$ teeth, as the number of teeth the lead-screw gear must be turned. Cut the first thread, bring the lathe to a stop, mark the intermediate gear and the gear on the screw, disengage them, move the lead-screw one full turn and 3 teeth, engage the gears, and the next thread may be started. Repeat this until the gear is finished.

Of course if the product in the formula does not contain the divisor without a remainder, the gear on the lead-screw must be changed until one is obtained which will give the desired results. The ratio must, of course, be retained.

Detroit, Mich. JOHN G. PAINE

[The reason why this rule will give correct results may not immediately be apparent. It is evident that what we want to do is to move the carriage forward a distance equal to the distance from one thread to the next, that is, equal to the linear pitch of the worm; in the example given this distance is 1½ ÷ 8 inch. As the lead-screw has 6 threads per inch it makes 6 revolutions when moving the carriage one inch. Hence,

to move the carriage 1½ ÷ 8 inch, it will make (1½ ÷ 8) × 6 revolutions. For each revolution 24 teeth are engaged. Hence, the total movement from one thread or start to the next equals (1½ ÷ 8) × 6 × 24, which may also be written in the form used by our correspondent.—EDITOR.]

THE PRINCIPLES OF PROJECTION

The writer believes that the general principles of projection—the reasons why the views are placed on a drawing the way they are—are not generally understood by mechanics and sometimes not even by draftsmen. In America, the method indicated in Fig. 2 appears to be universal, but in England there is really no universal way of projecting one view from another, as some use first-angle and some third-angle projection. In Fig. 2 is shown what is ordinarily termed third-angle projection, and which, undoubtedly, is the best way to show an object in a drawing. In this case the end views are placed nearest the end from which they are viewed. The plan is placed above the front elevation, and the bottom view or inverted plan is placed below the front elevation. An excellent way to demonstrate to students the reasons for showing the views in this manner, is as follows: Imagine a box having six glass

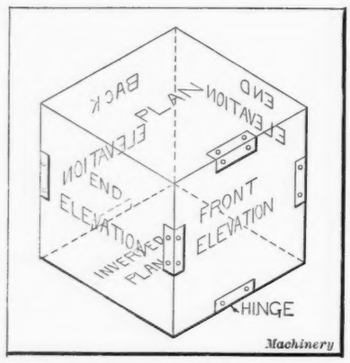


Fig. 1. The Third-angle Method of Making Projections as followed in America

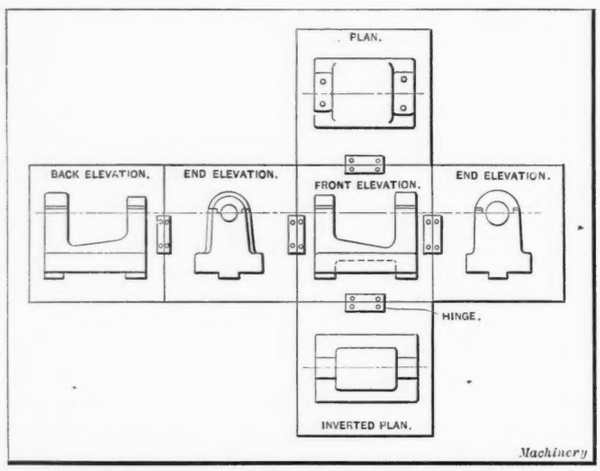


Fig. 2. A Simple Method to follow in making Correct Projections

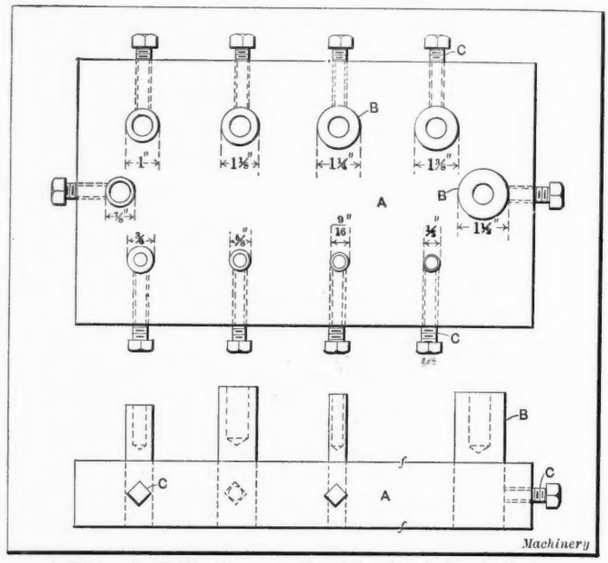
sides as shown in Fig. 1. Place an object inside of the box and draw the view of each side on the face opposite it. Then open the box and the views will be presented in a plan as indicated in Fig. 2. The writer has found this to be the best way of demonstration, and the easiest way to remember.

Belvedere, Kent, England. A. W. BOASE

FIXTURE FOR HOLDING LEVERS, ETC., WHEN FACING THE BOSSES

Every mechanic knows how troublesome it is to face the bosses of levers and brackets and get the faces true or at right angles with the holes. When the lever or bracket is strapped onto the drill press table, it is liable to spring in clamping, which results in the faced surface of the boss not being true with the hole.

The fixture shown in the accompanying illustration consists of a cast-iron parallel block *A*, 14 inches long by 8 inches wide by 2 inches thick, finished on both sides. This block has ten holes drilled in it varying in diameter from ½ to 1½ inch. Of course any number of holes can be drilled and the block made of a suitable size to handle the work for which it is to be used. The holes drilled in the block *A* are made to receive the studs or pins *B* which should be made from cold-rolled steel and casehardened. These studs have a hole drilled in one end to receive the pilot of the counterbore, and are adjustable in the fixture, being held when set to the desired height by means of the set-screws *C*. In the fixture shown in the illustration, the holes in the small studs are made ⅜ inch in diameter, while the holes in the large studs are made ⅝



A Fixture for Holding Levers or Brackets when facing the Bosses

inch. The studs *B* should be made to fit the hole in the lever or bracket snugly so that the boss will be faced true with the hole.

In use, the block *A* is fastened by clamps to the drill press table and the hole in the stud *B* is set in line with the pilot of the counterbore. The lever or bracket, after the hole has been drilled, is slipped onto the stud *B* and swung around until it touches one of the other studs, which acts as a stop. Stud *B* may now be set to the desired height, so that the lever will be faced to the required distance when the counterbore touches the top face of the stud. DAVID MCINNES

Plainfield, N. J.

CHAIN CASES

In the February number of MACHINERY, Mr. J. F. Winchester defends the unprotected chain on motor trucks. It seems to be his contention that trucks operate under conditions and on roads that are worse than those under which pleasure cars operate; hence, chains should not be protected. The truth of relative road conditions alone might properly be questioned, because touring cars are usually to be found wherever there are trucks, and very often in places impossible of access by trucks; but, granting the necessity for operating trucks on poor roads, does it not make the need of a protected chain all the more urgent?

Bearings in machines that do not operate in dirty surroundings do not need protection, as, for example, in the high-speed stationary engine. We have seen them operate successfully without being enclosed, and it was only a few years ago that completely enclosed splash oil systems of lubrication were first made. Such engines are now found in the cleanest power houses built, where the enclosure can be of value for facilitating lubrication only. Where there is dust and dirt, the covering serves a double purpose; the dirtier the surroundings, the greater the value of the cover. Certainly, if trucks run on dirtier roads, they are in greater need of protection.

Chain cases do not require much space on a vehicle and need not lessen the clearance between road and sprocket more than an inch, at most. Any driver who is competent enough to negotiate a road that is full of ruts without chain cases on his car, but who would break the cases, were the same chains

covered, would be a refined driver indeed. Besides, can a sprocket and chain withstand more rough treatment than a solid braced cover?

Chain cases as ordinarily located are in a large measure protected by the wheels. Hence, they are in less danger than gear boxes, which are invariably located in the center of the rear axle and directly exposed to the point where obstructions on unpaved roads usually exist. Yet, geared drives are invariably enclosed! The writer has several times repaired gear cases broken by striking obstructions on country roads. In every case, however, the vehicle was not immediately rendered useless. The oil ran out of the gear case, to be sure, and for that reason the transmission efficiency may have been slightly impaired by the accident, but the vehicle was still operative. If the uncovered gears had struck the obstructions, would they have kept going merrily on?

It is not illogical to compare chains and gears because of the difference in construction. In the operation of each form there is sliding contact—more in the gears than in the chain, true enough—and wherever there is sliding contact, abrasion is augmented by grit and dust; everybody knows that. The figures reported in the November issue of MACHINERY show this nicely. Chain manufacturers cannot compel machine manufacturers to cover the chains they use, nor do they insist on it strongly. It might be of interest, however, to know that one of the largest manufacturers of chains is endeavoring to show the user the importance of using cases, and in many instances this chain manufacturer's suggestions have been advantageously heeded. More data such as contained in MACHINERY'S November editorial will be of much value to automobile and chain manufacturers.

New York City W. F. SCHAPHORST

MORE COMMENT ON AUTO-TRUCK TRANSMISSION CHAINS

The use of uncovered chains is certainly indefensible on motor cars—trucks or touring. Any car, to be sure, is liable to have its chain break; but when that chain becomes laden with foreign material, the chain- and sprocket-wear increases to a great extent. The life of both the chain and the sprocket is shortened, and the car is out of commission oftener while renewals are being made. It is a small matter to design a chain case that can be removed quickly; the cost is nominal, and compared to the cost, the results are phenomenal.

No doubt the makers of chains know more about them than anyone else, so let me quote from the catalogue of one of the largest manufacturers of chains: "Chains should be housed and run in oil, the same as are gears, to give best results; but as an alternative they should by all means be protected from heavy grit or mud, the deposit of which increases the base diameter of the sprocket, resulting in rapid wear and elongation of pitch of both chain and sprocket." While we all did not wear out chains and sprockets on our bicycles, it is a matter of easy recollection how much easier "she" ran after we had taken off the chain and cleaned and greased it.

C. P. W.

WHY THE SHOP DOES NOT RETAIN THE SKILLED MECHANIC

In the January number of MACHINERY I noticed an article entitled, "Why the Shop Does not Retain the Skilled Mechanic," and would like to make a few comments on the opinions there expressed. I believe that the expert machinist and toolmaker is not required to the same extent today as he has been heretofore. Different methods of management are gradually eliminating the all-around man and developing specialists in all lines of work—expert lathe hands, planer hands, etc. Young men do not wish to start in as apprentices and work for $3.00 to $5.00 per week for several years, when they can start in with small experience on some one machine and earn considerably more. The young man of today does not want to waste his time—he considers it waste—by acquiring knowledge that he thinks he will never need. It is to be regretted that this type of man is becoming more and more common, but this is the reason, principally, why many large firms have discontinued their apprentice systems.

In regard to placing machinists and toolmakers on the honor system, it may be said, in the first place, that in very few shops does one now find any employes, except stenographers and bookkeepers, employed on the honor system. It has been proved that this system does not "work out" with the average man. It is too easy for him to be late or absent when no record is kept of his coming or going. Time-clocks would not have been installed if it had not been found to be necessary. Consider for a moment a large manufacturing plant employing, say, one thousand men. If only a few men were making a practice of being absent all or part of each day, the routine of the work would suffer. The time-clock is necessary for the simple reason that the average man thinks of no one's convenience but his own. It is much easier to come in late than on time, and those who may mean well enough, soon become careless.

It was also mentioned that it takes more skill to become a machinist or toolmaker than to become a draftsman, and, therefore, the former man should have as much, if not more, consideration than the latter. Perhaps the writer of the article referred to, never worked as a draftsman, and in that case he is excused for the remark. Comparatively few machinists or toolmakers, when they have finished their day's work, give a thought to it until the morrow. On the other hand, most draftsmen, no matter in what line of work they may be, have to study or work out problems that have come up in their daily work, at least, say, three nights a week. A writer in a magazine recently said that "men employed in engineering work have a most confining life for that very reason." Besides this, a draftsman has to work hard many years with his books before he is able to fill his position.

I do not mean this to be direct criticism of the position taken by the former writer, for he may have found the facts as he stated them to be true in his case; but the opinion I have expressed is based on the facts as I have found them in a number of large manufacturing establishments.

Philadelphia, Pa. EDWARD R. GLENN

A SIMPLE TAPPING FIXTURE

Having occasion to tap several thousand swaged nuts of the form shown in Fig. 1, a fixture to be used on a horizontal tapping machine, as shown in Fig. 2, was designed. This fixture consists of a cast-iron angle-plate *A*, to the front face of

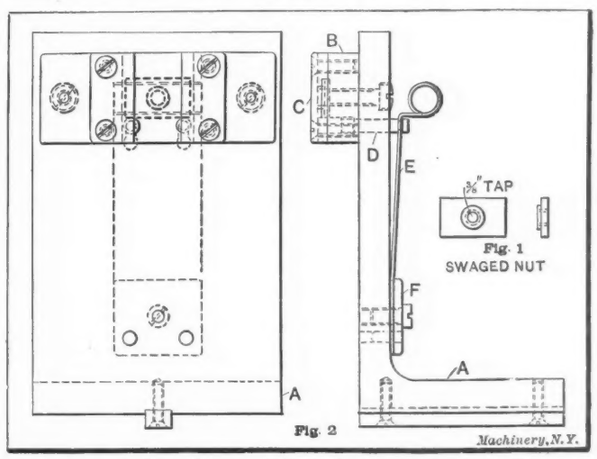


Fig. 1. The Swaged Nut. Fig. 2. The Fixture used for Holding the Nut while tapping

which is attached a soft-steel block *B*. Fastened to this block *B* are two guide strips *C*. Two hardened shoulder pins *D* which pass through the blocks *A* and *B* act as stops for the nut while being tapped. Attached to these stops and fitting over a groove turned on them, is a flat steel spring *E*. The holes in this spring are made keyhole-shaped, so that the spring can be inserted over the pins and then brought down into position, where it is held with the block *F*, a screw, and two dowel pins, as shown. The top of this spring is formed into a ring, so that it can be conveniently handled.

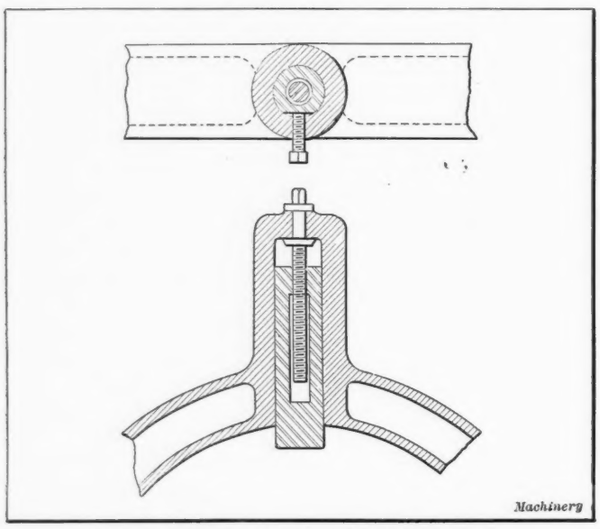
In operation, the nut shown in Fig. 1 is placed in the

guides, and rests on the pins *D*. The machine table is then moved forward, carrying the angle-plate, and the tap passed into the nut. The table is then withdrawn, and when the tap emerges, the spring *E* is pulled back, which withdraws the pins *D*, thus allowing the nut to drop into a pan placed on the table to receive it. This device can be cheaply made, but should be judged from its efficiency rather than its simplicity.

Detroit, Mich. ARON LAWRENCE

A LATHE STEADYREST OF UNCOMMON DESIGN

The accompanying illustration shows a lathe steadyrest which varies from that usually supplied by the lathe builders of today. The general outline and construction of the rest is the same, but the jaws are different. The ordinary rectangular jaw is replaced by a cylindrical piece fitting



A Lathe Steadyrest of Simple and Rigid Construction

snugly in a bored hole, as shown, which is adjusted by means of a screw. These jaws may be made of any material depending upon the work on which they are to be used. We use jaws made from steel on heavy lathes, when large cast-iron drums are turned. This construction is very rigid and is of simple design. H. TERHUNE

Plainfield, N. J.

THIS IS "ABSOLUTELY" TRUE

"Say, Bill, what was the matter with the boss and the young fellow that just left?"

"Well, you see, everybody, in the last few years, has been using the word 'absolute' in connection with the work turned out on their machines. That fellow came in and said to the boss, 'You ought to plane those plates on one of our machines; they plane absolutely true surfaces,' and I heard the old man tell him a little experience.

"'Young man,' he said, 'I want to give you a pointer. I had heard one fellow say that his machine grinds absolutely true, another that his turns absolutely true, another that his mills absolutely true, and another that his pulleys and shafting run absolutely true, for so long that I got the disease and agreed to build a machine for that old fellow down by the railroad track who hammers saws and does blacksmithing, that would grind saws absolutely true on their sides. Now I will tell you what happened to me because I did not know what the word 'absolute' meant. After I had built the machine and sent it down, and thought I had given him about enough time to pay for it, I decided to call around for the money. Now, I had seen some of the work turned out on it and had a letter from a man who had seen it wanting me to build one for him, so I felt sure everything was O. K.

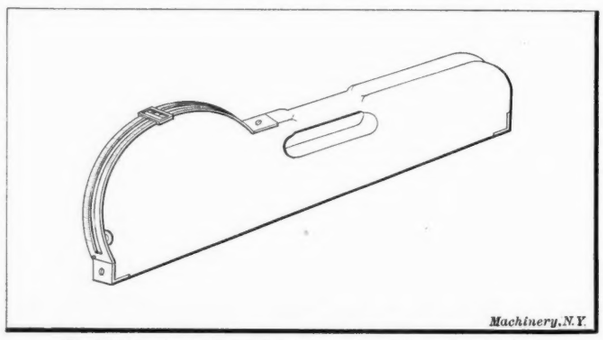
"'As I entered and stated my reason for calling, he asked me to look at some of the saws which were ground on this machine. He reached up on a shelf and got a nice new straightedge, and suspended a saw by a string hooked over the teeth and then held the straightedge against it. With the other hand he shoved the 0.004 inch blade of a feeler through, between the straightedge and the saw. Then without saying another word, he got my contract and pointed to the clause in which I agreed to produce a machine which would grind absolutely true. I requested him to put a saw in the machine and let me adjust it, and I proceeded to grind a saw. When I had it finished and the saw tallied with the straightedge, I called him over. He looked at it, and then got a surface plate about 10 inches square, and thinly covered it with lamp black and rubbed it over the surface just ground. Upon removing it, he informed me that the machine must grind absolutely true before he paid the bill.

"'Then it dawned upon me that I had used a word to convey one meaning that really meant another. I could not convince him of the injustice of his demands, and we went to law. My attorney could make no impression upon the court, which simply stated that if I agreed to build a machine to fly ten miles, the simple fact that it was impossible to do so did not entitle me to receive pay for a machine that would nearly fly. The above incident took place twenty years ago. We have since accomplished what was then considered an impossible thing, *viz.*, the flying machine, but are practically as far from producing machinery that does work absolutely true, as we were then. The only satisfaction which I got was that the machine was returned to me. I soon disposed of it, but it taught me a lesson.'" J. G. D.

GONIOMETER OR ANGLE-MEASURER

The goniometer, or angle-measurer, illustrated herewith is the invention of a German and is intended to measure the angle of an object on which it is placed without the use of any ways, screws, etc., it being merely necessary to lay the instrument on the object and read the angle off directly on the semi-circular scale at the left.

It consists essentially of a glass tube, bent into a circular form and filled with liquid; a bubble in this liquid, as in ordinary levels, tends to keep to the top. A sliding piece on a



The Goniometer, a German Instrument for Measuring Angles

circular scale is placed over the bubble and set in that position, thereby indicating the angle. This sliding piece also makes it possible to set the indicator and then remove the goniometer to a lighter place where the angle may be more easily read. In making this instrument, the one precaution necessary is to bend the glass tube containing the liquid to a perfectly circular form. ROBERT GRIMSHAW

Dresden, Germany.

A COUNTERBORING TOOL AND FIXTURE

While the automobile engineers are busy improving and perfecting their latest models, incidentally they are developing some very interesting machine and tool problems. The latest of these to come to the writer's attention was the facing and counterboring of a 5-inch diameter by 6-inch stroke cylinder. It appears that by the constant wearing of the piston rings upon the cylinder wall, a slight shoulder was formed near the extreme end of the piston ring travel in the cylinder. This shoulder however slight causes a piston knock when the piston ring reaches it. The resulting sound or knock could hardly be distinguished in the open, but as the knock occurs inside the cylinder which is closely connected with the crank case, the latter acts as a sounding box deceiving the ear to

such an extent that it is necessary to use a phonendoscope or vibracator to make sure of its location. To overcome this noise our engineer decided to relieve the cylinder bore at the upper end, so that the upper piston ring would travel about one-half its width above the counterbored recess. The tool shown in Fig. 1 was designed to perform this operation and was used in the fixture shown in Fig. 2, the fixture being held on a machine of the two-spindle vertical type which was formerly used for reaming cylinders.

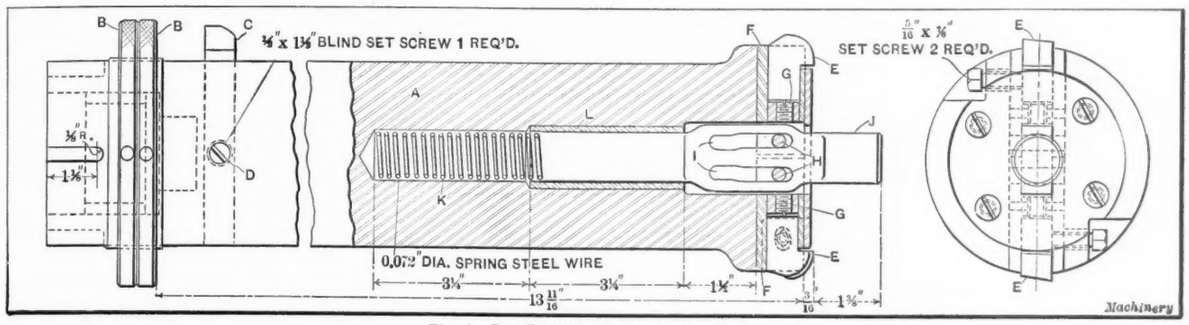


Fig. 1. Details of the Counterboring Tool

As shown in Fig. 2, the counterboring tool extends down into the cylinder to the required distance, and the tool-heads carrying the turning tools are operated by cam grooves in the central plug. The body of the tool *A* is made of machine steel, threaded in the upper end to closely fit the nose of the spindle of the machine. The total length of the body of the tool is 16 inches, and it is made of large diameter so as to afford sufficient support to the cutters to prevent chattering. The position of the counterbored recess is governed by stop collars *B*, which gage from the upper surface of the jig that holds the gas engine cylinder. Held in the body *A* by a screw *D* is a tool *C* which chamfers the open end of the cylinder to an angle of 45 degrees. The counterboring tools *E* are held in the tool-holders *F* and are adjusted by screws *G*. Driven into the tool-holders *F* are pins *H*, which operate in cam slots *I*, cut in the central plug *J*, the latter being operated upon by the spring *K*. The central plug *J* is fitted in a bronze bushing *L*, held in the body of the holder.

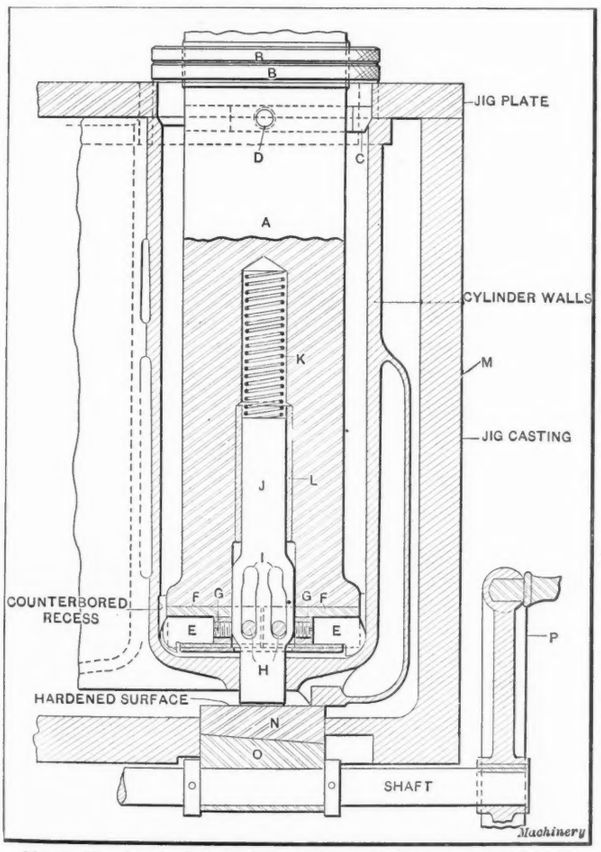


Fig. 2. Showing the Cylinder in the Fixture and the Counterbore at Work

In operation, the cylinder is clamped in the jig *M*, Fig. 2, and the body *A* inserted until the stop collars *B* come into contact with the top of the jig. At the same time the central plug *J* comes in contact with a hardened wedge *N*, which forces the former up into the body against the tension of the spring *K*—thus expanding the cutters. As the body *A* still continues in its downward movement, the cutters are kept to the same diameter by means of the straight portion of the cam slots, the extreme downward position of the cutters being governed by the washers *B* as previously mentioned. Adjustment for the central plug *J* is provided by a hardened wedge *N*, which is operated by the beveled plug *O* and handwheel *P*. The spring *K* has a very important function to fill, as the operation of the cutter depends entirely on its action. The tool-holders *F* are made from tool steel and are somewhat expensive to make, but as it is possible to hold short tools in them, a saving in steel is thus effected. The constant cutting in the hard scale and sand in the cylinder dome, requires frequent resharpening of the cutting tools, and when worn to the limit of the adjusting screws *G*, they must be replaced. The best high-speed steel obtainable is used for these cutters so that the smaller the cutter, the less the cost of maintenance will be.

Lansing, Mich. E. H. PRATT

SOME OBSERVATIONS ON GEARING

Speaking from practical observation and experience I believe that it is wrong to calculate the strength of steel gears as if they were able to continuously transmit two or more times the power transmitted by cast iron. I am not referring now to gears that run only intermittently, because with them it is more a question of strength than of wearing qualities, and I am referring only to ordinary steel forgings and castings, and not to alloy steels.

Ordinary cast iron on cast iron is a good combination so far as wear goes, while soft steel on soft steel, or on steel castings, is an exceedingly poor combination, as anybody can prove by using a steel shaft in a steel bearing. Why then should we expect steel teeth to wear as well as cast-iron teeth for the same load? And further, why should we expect them to endure under twice the load that cast iron is supposed to be able to carry? As a matter of fact, steel gears thus loaded are short-lived and uneconomical when run for eight or ten hours a day. I know of a great many instances that could be cited in support of this statement, and if any one of the readers of MACHINERY could name a case where steel gears will wear well when continuously transmitting anything like the loads allowed by the Lewis factors, I would be interested to know the details. I do not want it understood that I advocate cast-iron gears for I do not, but I advocate using the same factors when calculating steel gears as when calculating cast-iron gears, as far as the teeth are concerned. An ample margin for wear is just as important an economy for the purchaser of gears as it is in any other machine part. This is particularly true in the case of gears, where the labor cost is great in proportion to the cost of the material.

There is another thing that observation leads me to believe is more often done wrong than right, and that is the locating of the shaft centers for a pair of gears. I believe that they should be located enough closer than the theoretical distance,

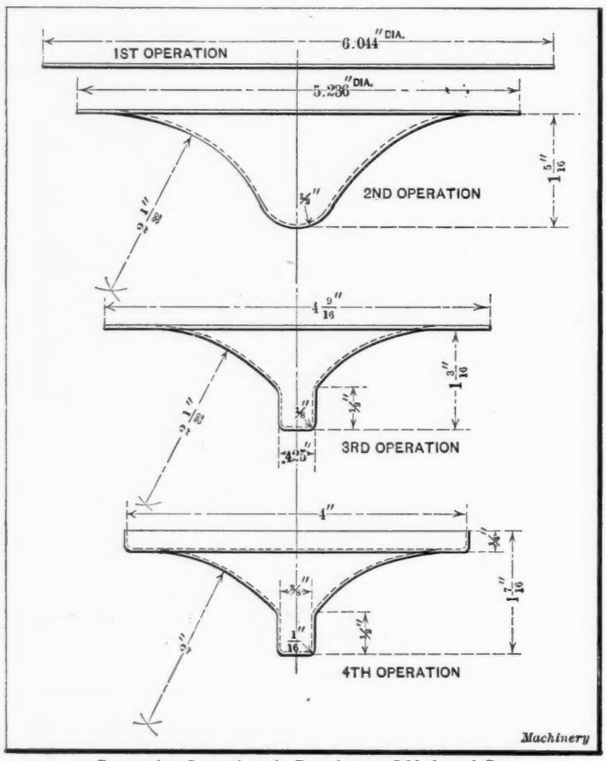
so that when the thrust of the teeth forces them apart by the amount of play there is in the bearings, they will be at the correct center distance. I believe that a great many breakdowns are due to the fact that the teeth do not mesh properly, because the centers of the gears are forced too far apart when loaded.

From a somewhat limited experience with worm-gear drives I have concluded that a well-designed worm and worm-wheel of high thread angle, made of the right materials and working well inside of the safe limits of pressure and speed, are much more satisfactory than two spur gears and two bevel gears to gain the same reduction and change of direction.

Scottdale, Pa. F. D. BUFFUM

THE DRAWING OF AN ODD-SHAPED CUP

In the February number, J. M. asks for advice relative to the drawing of an odd-shaped cup. In the writer's opinion this is a job in which considerable difficulty will be encountered. Owing to the small dimensions of the shank on this piece it does not seem feasible to do the work in less than four operations, as shown in the accompanying engraving.



Successive Operations in Drawing an Odd-shaped Cup

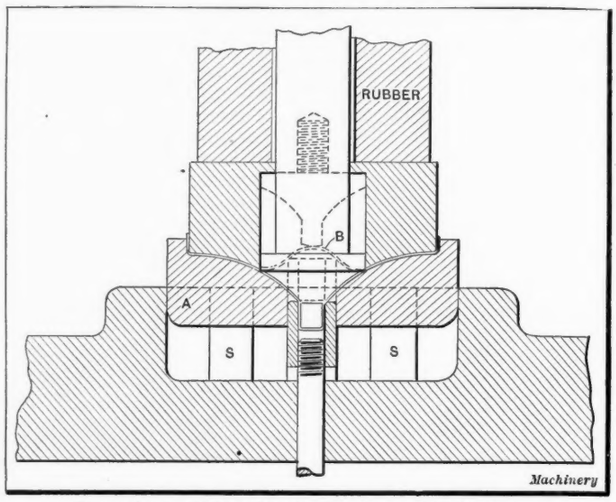
If it were attempted to do the work in a smaller number of operations, there would be considerable waste, in rejected pieces, as the metal would not flow fast enough to fill up, and the punch would break through.

As will be seen from the illustration, the metal is drawn out by easy stages until somewhat near the finished outline, before the sharp corners required are given to it. By the form of the question, the writer is led to think that J. M. is not equipped with good die-makers for making the dies. If that is the case it would be advisable to submit a sample of the piece required to some firm making a specialty of this class of work, so that this firm could bid on the dies, and decide exactly how they ought to be made and what would be the cost.

Fort Wayne, Ind. H. R. TALMAGE

DRAWING AN ODD-SHAPED CUP

In the February number of MACHINERY, J. M. asks for information regarding the tools necessary to make an odd-shaped cup. The accompanying illustration may serve as a suggestion as to the main features of the die equipment required. The dotted lines at *B* show the shape of the cup after the first operation, a combination cutting, drawing and embossing die being used for this. The dotted lines also indicate the location of the blank at the beginning of the working stroke of the second operation. With a two-inch stroke, provision must be made for the removal of the cup after forming. As a suggestion, the slots *S* are indicated, into which



Suggestion for Making Dies for Drawing an Odd-shaped Cup

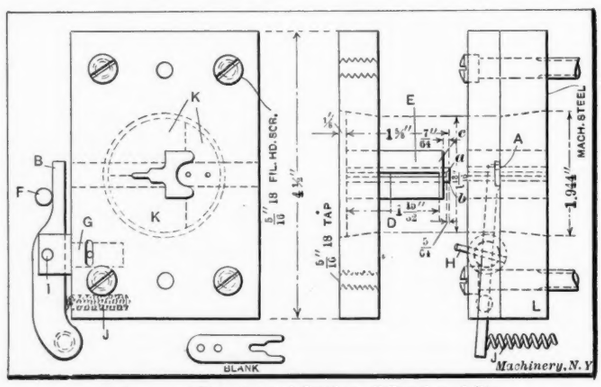
parallel wedge blocks are placed. These can be withdrawn after the stroke is completed, to allow the lower pressure ring *A* to fall and provide the required opening between the dies.

Columbus, Ohio. OTTO R. WINTER

A PIERCING AND CUTTING-OFF PUNCH AND DIE

An interesting punch and die for piercing and cutting off a typewriter part, is shown in the accompanying illustration. The stock which is a narrow strip, is fed through the channel *A* against the stop *B*, and is pierced and cut off by the punches *D* and *E*. The face of the punch *E* is made of varying heights, the forward part or face *a* and the following part or face *b* are both lower than the cutting-off face *c*, so that the slot will be cut in the blank before it is severed from the strip. The small holes in the forward end of the blank are pierced by the punches *D*, the faces of which are higher than the faces of the blanking and cutting-off punch *E*.

In operation, when the stop *B* is lifted, it swings in toward the die and rests on top of the finished blank, which is forced out of the channel when the strip is fed forward. When the blank drops out, the stop snaps down and engages the end of



Progressive Piercing and Cutting-off Punch and Die

the strip, and is forced by the latter against the pin *F*. The stop *B* rotates on the pin *G*, which is prevented from pulling out by the pin *H*. The stop *B* swings laterally on the pin *I*, and springs *J* are for actuating the stop.

The die proper is made up of three segments *K*, which are tapered and are driven into the die-block *L*. Two of these segments are symmetrical and can be milled out in one piece, then sawed apart before the taper for fitting them in the die-block is turned. To turn the taper on the die, the three pieces are soldered together and the punch is used as an arbor.

DESIGNER

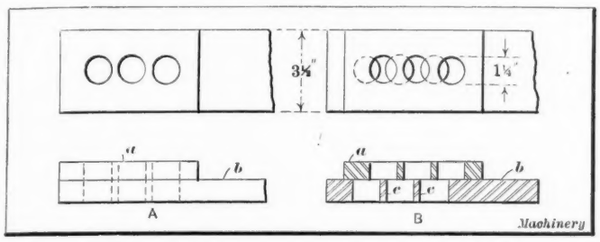
SHOP KINKS

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.

DRILLING ELONGATED HOLES

A simple method of drilling elongated holes is shown in the accompanying illustration. A plate *a*, which can either be made of machine steel and casehardened or furnished with hardened bushings, is clamped to the piece *b* to be drilled. The three holes, as shown at *A*, are then drilled

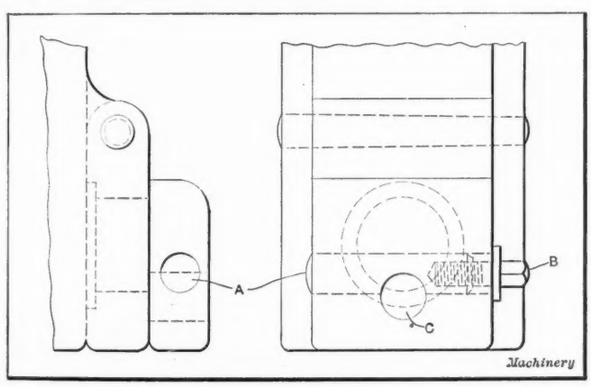


clear through, after which the block *a* is shifted to the position shown at *B*, and the remaining webs *c* are drilled out with an ordinary twist drill, ground square on the end. Preferably a high speed and light feed should be used; high-speed drills will be found to give better satisfaction than ordinary carbon drills.

SUBSCRIBER

EXTENSION TOOL-HOLDER FOR A SMALL SHAPER

In model and experimental work it frequently happens that the work to be handled in the shaper requires a tool projecting further than can be obtained with a regular tool. To meet such cases the clapper block shown in the accompanying illustration was made for the purpose of holding



an extension bar, in the end of which the cutting tool is held.

Referring to the illustration, *A* is a round rod into the end of which is tapped a hole for the screw *B*. A hole *C*, bored in the block at right angles to the rod *A*, provides an opening for the extension tool-holder. By tightening the screw *B*, after placing the tool-holder in position, the latter is held securely, the rod *A* acting as a clamp.

Hartford, Conn. F. CHARLES SCRIBNER

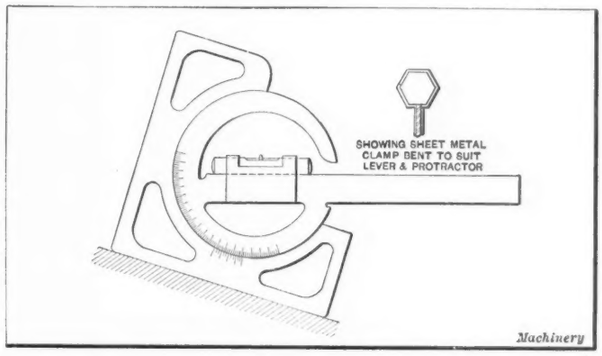
FACING WORK ON THE LATHE FACEPLATE

In facing on the lathe faceplate, it is common practice to pack up the work with tissue paper to prevent it from slipping around, and also to avoid the necessity of clamping it too tightly. Another method which is equally as good, if not better, is to deposit a thin coating of oil and fine emery between the work and the faceplate, spreading it evenly. This method allows a heavy chip to be taken when the work is clamped lightly. Still another method is to apply a thin coating of hot shellac to the faceplate, and also a thin coating to the side of the work that will be placed next to the faceplate. The faceplate is removed from the lathe and the work placed on quickly and moved around; then a weight is placed on it and left until the shellac is dry, after which the faceplate can be put on the lathe and the cut taken. This method requires no clamps at all, and was used with satisfactory results by the writer in taking a finish-facing cut from a cast-iron disk 6 inches in diameter and 1/32 inch thick.

Newark, N. J. H. E. WOOD

OBTAINING ANGULAR MEASUREMENTS WITH A B. & S. DRAFTSMAN'S PROTRACTOR

It frequently happens that a draftsman finds it necessary to measure an angular surface on a machine, but cannot do so because there is no finished surface to take the measurement from. The accompanying illustration shows how an angular measurement can be taken. This is accomplished by means of a Brown & Sharpe draftsman's protractor to which

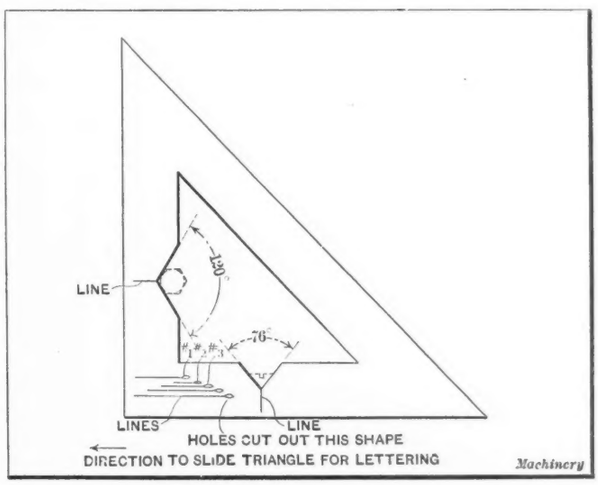


an L. S. Starrett level is attached by means of a piece of flexible material such as sheet tin, zinc or steel. The protractor can be placed on the angular face of the machine and the arm raised until the spirit level shows that the arm is in a horizontal plane, when the angle can easily be found.

F. D.

DRAFTSMAN'S TRIANGLE FOR DRAWING BOLT AND SCREW HEADS

The triangle shown in the accompanying illustration will be found convenient for drawing bolt heads, flat-head screws and laying out spacing lines for uniform lettering. Take a 45-degree triangle, preferably celluloid, and lay out the angles, as shown. The portion cut away at 120 degrees is for hexagon-head bolts, while that part cut away at 76 degrees is for flat-head screws. The small holes marked Nos. 1, 2, 3, etc.,



are so arranged that different spacings for lettering can be obtained. The space between 1 and 2 is ⅛ inch, while the distance between 1 and 3 is 5/32 inch. The point of the pencil may be inserted in these holes, and the triangle moved along in the direction indicated, thus drawing the spacing lines for the lettering.

H. F. FLOHN

Newark, N. J.

HOW AND WHY

DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details in full and name and address. The name and address will not be published with the answer

METAL PAINT TO WITHSTAND ALCOHOL

S. J. B.—It is required to paint a brass vessel having a glass top with white paint which will successfully withstand the action of diluted alcohol in the proportion of 2 to 1 without the paint changing color. What mixture of paint should be used?

This question is submitted to the readers.

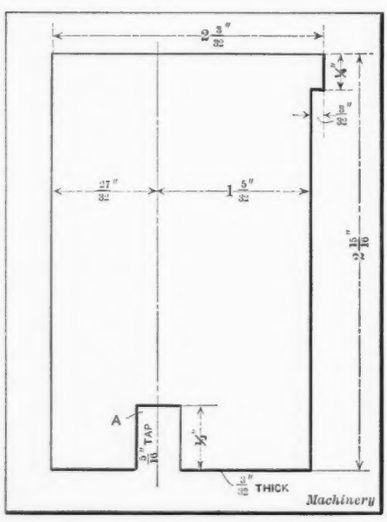
PROPORTIONS OF SHORT HYDRAULIC CYLINDERS

J. C. S.—The formula $\frac{R}{r} = \sqrt{\frac{S+P}{S-P}}$ in which R is the outer radius of the cylinder; r, the inner radius; S, allowable unit stress; and P, maximum pressure, gives the ratio between the outer and inner radii of thick hydraulic cylinders for given internal pressures. This formula does not apply to very short cylinders, however, because of the reinforcing effect of the thick head. The rule given by Kent for short cylinders is to make the thickness one-tenth the inner circumference for pressures of 3000 to 4000 pounds per square inch. I have to design a cylinder for 5000 pounds pressure, 8¾ inches internal diameter and 3 inches stroke. The material will be semi-steel, having a tensile strength of about 25,000 pounds per square inch of cross-section. Figured by the Kent rule an external diameter of 14¼ inches is safe for a pressure of 4000 pounds. Will a diameter of, say, 15¾ be safe for 5000 pounds? Figured by the first-mentioned formula the external diameter must be 22 inches, allowing a fiber stress of 7000 pounds per square inch.

The question is submitted to readers who are familiar with the modifications of theoretical design in such cases, enforced by commercial considerations.

BROACHING SCREW THREADS IN THIN PLATES

R. H. F.—I am building a machine in which there are 35 steel knives 3/32 inch thick which are held on a spider or knife plate with 5/16 inch—18 thread screws tapped into the slot *A*. The metal is cold-rolled steel, and the slot is 1/2 inch long. We punch the slot in a punch press and then put the knife in a small jig and tap the threads by hand. What I wish to know is, can the knives be tapped more rapidly in some other way, as our present method is slow and expensive?



A.—Inasmuch as the threads are tapped into the edge of the knife blade which is only 3/32 inch thick, the angle made by the thread is practically negligible. We suggest that the outline of the threads be broached with a suitable broach in a power press. The screw will have practically as good a hold of the knife when screwed into the broached thread shapes as though they were tapped. Of course, the bearing of the screw will not be theoretically correct, but by the time the screw is screwed home the bearing should be practically as good as is required for this class of work.

STATUS OF "PATENTED" ON MACHINES

S. J. R.—What is the law regarding the use of the word "patented" on manufactured articles; also with regard to blanket nameplates giving the dates and numbers of all patents owned by the concern making the products? I have noticed machine tools bearing nameplates on which legends similar to this appear: "Made by the Brown & Smithson Machine Tool Co., Brownsmithsonville, Ohio, operating under patents," followed by a list of all the patents owned by the company, giving the numbers and dates of issue. The machine carrying the nameplate may be a standard machine tool without a single patentable feature, yet it appears to be plastered with patents.

A.—Section 4900 of the United States Revised Statutes provides that when a patented article is not marked "patented" no damages shall be recovered by the plaintiff unless he proves that the defendant was duly notified of infringement. Section 4901 provides a penalty for marking "patented" on unpatented articles when done for the purpose of deceiving the public. So far as we can ascertain no decisions of the courts have been recorded regarding the use of blanket nameplates on machines, listing all the patents owned by the manufacturer. The practice has certain advantages for both the maker and user. It enables one style of nameplate to be used on all styles of machines produced, irrespective of their characteristics. The user is informed just what patents are owned by the company, but whether any of them apply to a particular machine is left in doubt.

JIGS AND FIXTURES—HOW DEFINED

D. T. H.—What are your definitions of "jig" and "fixture"?

A.—The answer is in the editorial under the above heading in the February, 1905, number, part of which follows: "Jig and fixture are words used interchangeably; a drilling-jig and a drilling-fixture may be one and the same thing—and they may be different, as we shall see later. Broadly, a jig is a device used in interchangeable manufacturing of machine parts for holding the work pieces and guiding cutting tools in any machining operation thereon; hence it may be used for drilling, boring, milling, planing, shaping, etc., but, we believe, it is preferably limited in general use to the first two operations, that is, drilling and boring. While fixture is a term generally used to mean the same thing, we believe that it is more comprehensive, and that it includes a lot of things which would not ordinarily be called jigs. If the device is of such a nature that it incloses and holds the work so that it can be lifted and transported as a whole, and, perhaps, has provision for a number of operations in different planes, we should surely call it a jig, but if it were the radius attachment to a planer for planing locomotive links, we should call it a fixture, although it is by no means a fixed or permanent part of the machine. A drilling vise is more of a fixture than a jig, but if it is provided with guide bushings we would term it a drill-jig or a jig-vise. Again a fixture may be one of the tools of a machine, as for example, the tools and fixtures of a turret lathe. A tool-post is an example of a fixture, but it is not a jig in the ordinary sense of the word. An "old man" for ratchet drilling is a fixture, as is also a former used on a planer as in planing relief for locomotive driving boxes, or as applied to the lathe for turning machine handles. A bending device which insures exact duplication is usually called a fixture, in preference to jig. A device for holding work pieces on the milling machine so as to insure duplication of parts is preferably called a fixture, although in many shops it would be called a jig. Hence the difficulty in assigning any definite and limiting meaning for either term. One difference that may be assumed to exist between jig and fixture is that a jig holds the work and guides the cutting tool independently of the machine supplying the driving power and feed, while the fixture is usually dependent upon the machine to guide the cutting tool or the work; one is self-contained and the other is not. We are fully aware that this distinction does not exist in actual practice, but it is one put forward as a suggestion for those shops which wish to define shop terms precisely."

STRESSES IN ELASTIC COUPLING

H. M. L.—The accompanying illustration, Fig. 1, shows a flexible coupling of the type in which a leather belt, looped around pins, transmits the power. How can the stress in the belt wound around the pins be calculated?

A.—In Fig. 2 a diagram is shown, indicating the necessary geometrical construction for finding the stress in the belt.

The radius of the outer pin circle is R and of the smaller, r. The radius of the pins is p, the number of pins is N in each pin circle, and α denotes the angle between the lines through the centers of adjoining pins. The requirement is to find the angle that line DE makes with a tangent to the outer pin circle, so that the tangential force to be transmitted can be translated into belt stress along line DE. Angle $\alpha = 360 \div 2N$. As we also know R and r, we can find the length of side BC in triangle ABC, by a simple trigonometric formula, and also the angle ABC. Then, in triangle CDF, $CF = \frac{1}{2} BC$,

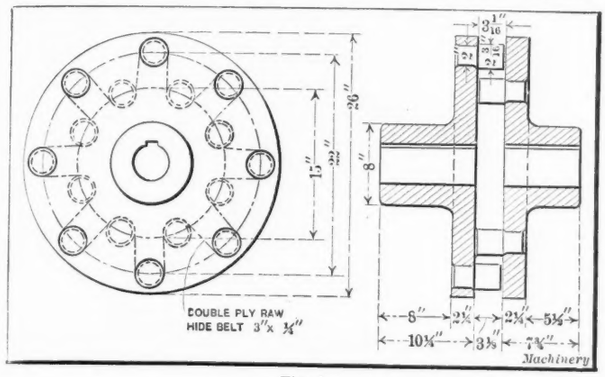


Fig. 1

$CD = p$, and angle CDF is a right angle. Hence angle CFD can be found, the sine of this angle being equal to $CD \div CF$. The angle that DE makes with AB, then, is equal to angle ABC — angle CFD, and the angle that line DE makes with a tangent through B equals 90 degrees minus this angle. The angle with the tangent will be denoted β. For the sake of simplicity, assume that the tangential force acts at the center of the pin, at B. In the force diagram, at the right, KL represents the tangential force at each pin, and KM the stress in the belt, the angle between the direction of these forces being β. Assume that P represents the total tangential force to be transmitted. If the horsepower to be transmitted is known, then $P = (33{,}000 \times \text{H. P.}) \div (2\pi R \times \text{R. P. M.})$, and the

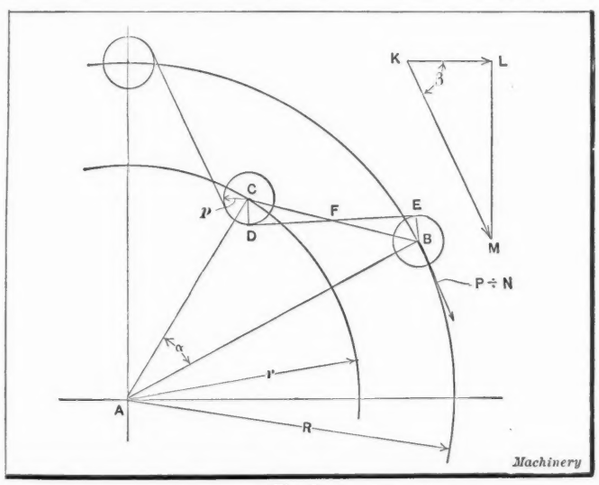


Fig. 2

force represented by $KL = P \div N$. From this we find KM, or the belt stress, is expressed as:

$$KM = \frac{P}{N} \div \cos \beta = \frac{P}{N \cos \beta}$$

Extreme refinement in this calculation is not necessary, as the relative positions of pins B and C do not remain constant, due to the elasticity of the belt, and hence the value of angle β will vary. The value found as shown, however, is the one which produces the maximum stress; with the coupling in torque, angle β will decrease, in which case the stress in the transmitting belt will decrease also. It is evident that the stress becomes very great if β is large, and as this angle depends upon the arrangement of the pins, it is advisable to make the difference in the radii of the pin circles as small as is consistent with the angular displacement required to absorb the shocks of transmission.

SPIRAL-FLUTED HOB ANGLES*

By G. H. GARDNER†

It is, of course, desirable that hobs should be fluted at right angles to the direction of the thread. Sometimes, however, it is necessary to modify this requirement to a slight degree, because the hobs cannot be relieved unless the number of teeth in one revolution, along the thread helix, is such that the relieving attachment can be properly geared to suit it. In the following it is proposed to show how an angle of flute can be selected that will make the flute come approximately at right angles to the thread, and at the same time the angle is so selected as to meet the requirements of the relieving attachment.

Let C = pitch circumference,
T = developed length of thread in one turn,
N = number of teeth in one turn along thread helix,
F = number of flutes,
α = angle of thread helix.

Then (see illustration):

$C \div F$ = length of each small division on pitch circum.
$(C \div F) \times \cos \alpha$ = length of division on developed thread.
$C \div \cos \alpha = T$.

$$\text{Hence } \frac{T}{(C \div F) \cos \alpha} = N = \frac{F}{\cos^2 \alpha}$$

Now, if $\alpha = 30$ degrees, $N = 1\ 1/3\ F$,
$\alpha = 45$ degrees, $N = 2\ F$,
$\alpha = 60$ degrees, $N = 4\ F$.

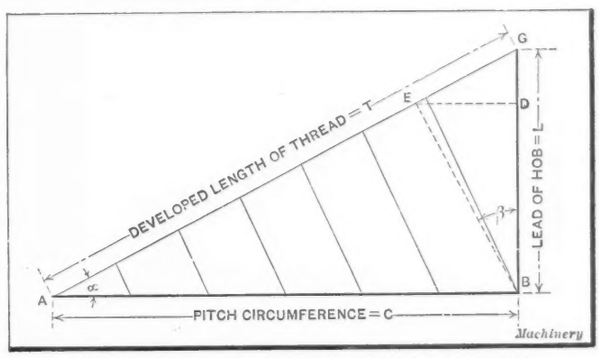


Diagram for Derivation of Formula for Spirally Fluted Hobs

In most cases, however, such simple relations are not obtained. Suppose for example that $F = 7$, and $\alpha = 35$ degrees. Then $N = 10.432$, and no gears could be selected that would relieve this hob. By a very slight change in the spiral angle of the flute, however, we can change N to 10 or 10½; in either case we can find suitable gears for the relieving attachment.

The rule for finding the modified spiral lead of the flute is: *Multiply the lead of the hob by F, and divide the product by the difference between the desired value of N and F.*

Hence, the lead of flute required to make $N = 10$ is:
Lead of hob $\times$ $(7 \div 3)$.
To make $N = 10\frac{1}{2}$, we have:
Lead of flute = lead of hob $\times$ $(7 \div 3.5)$.
From this the angle of the flute can easily be found.

That the rule given is correct will be understood from the following consideration. Change the angle of the flute helix β so that AG contains the required number of parts N desired. Then EG contains $N - F$ parts. But $\cot \beta = BD \div ED$, and by the law of similar triangles,

$$BD = \frac{F}{N} \times BG, \text{ and } ED = \frac{N - F}{N} C$$

The lead of the spiral of the flute, however, is $C \times \cot \beta$.

Hence, the required lead of spiral of the flute:

$$C \times \cot \beta = \frac{F}{N - F} L$$

This simple formula makes it possible always to flute hobs so that they can be conveniently relieved, and at the same time have the flutes at approximately right angles to the thread.

* See also MACHINERY, December, 1910, engineering edition, "Gashing Spiral Fluted Hobs."

† Address: 101 Eustis St., Revere, Mass.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BROWN & SHARPE INTERNAL GRINDING MACHINE

The Brown & Sharpe Mfg. Co., Providence, R. I., has recently placed on the market an internal grinder that is designed for general internal grinding operations. This machine has a capacity for grinding holes varying from 2½ to 12 inches in diameter and 8 inches deep, and the machine will swing 18 inches. By using a special spindle, holes less than 2 inches in diameter, but not exceeding 12 inches deep, can be ground. This machine is especially adapted for grinding holes in hardened steel gears, cutters, collets, bushings and similar work. Taper holes can also be ground as easily and accurately as those that are straight, and such work as facing recesses in automobile gears to obtain a bearing true with the hole can be done without removing the piece from the machine.

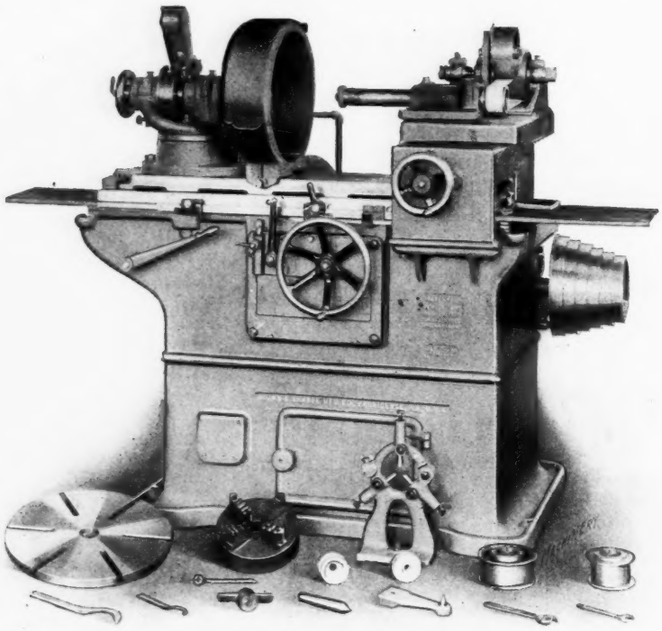


Fig. 1. Brown & Sharpe No. 22 Internal Grinding Machine

The design and construction of this machine, front and rear views of which are shown in Figs. 1 and 2, respectively, gives evidence of a careful study of the requirements for a grinder of this type. The general operation of the machine is as follows: The work to be ground is fastened either in a chuck or on a faceplate mounted upon the work spindle, which is driven from the overhead works. The headstock carrying the work spindle is fastened to the table of the machine, and the latter has an automatic, reversing, longitudinal movement similar to that of universal and plain grinding machines. The grinding-wheel stand and slide are mounted on a heavy bridge, which is bolted to the right-hand end of the machine bed and spans the work table. The grinding-wheel spindle is driven by a web belt from an intermediate shaft mounted at the back of the wheel-stand as shown, and this intermediate shaft, in turn, is belted to the over-head works.

The work speeds and table feeds of this machine are independent, the same as with the universal and plain grinders built by this firm. This arrangement makes it possible to obtain a correct table feed for any work speed. For example, when it is desired to remove stock rapidly, a slow speed and fast feed are available. Both work and table feeds are started and stopped by a single lever located on the front of the machine.

All wearing surfaces throughout are adequately protected from grit. The ways of the bed are always covered and the oil holes are protected from grit and dust. All screws, bolts and nuts requiring frequent adjustment are hardened. The handwheels and levers for controlling the various movements of the machine are all placed at the front.

Wheel Spindle, Stand and Slide

The wheel-spindle is of hardened tool steel and is enclosed in a heavy sleeve that extends practically its full length. The spindle and sleeve form a separate unit, which can be removed easily and quickly in case another spindle and sleeve of smaller size is to be used. At the front end of the spindle and close to the wheel there is a phosphor-bronze box in the sleeve, and at the pulley end an annular ball bearing is provided to take the pull of the belt and reduce friction to a minimum. The different grinding wheels used are mounted on a sleeve, which has a taper hole that fits the end of the spindle.

An ample range of independent spindle speeds is obtained by the use of interchangeable split pulleys on the intermediate shaft at the back of the wheel-stand. An idler pulley is provided to keep an even tension on the belt and take up the slack resulting from the use of pulleys of different diameters. Three split pulleys are furnished providing for speeds varying from 3990 to 7300 revolutions per minute.

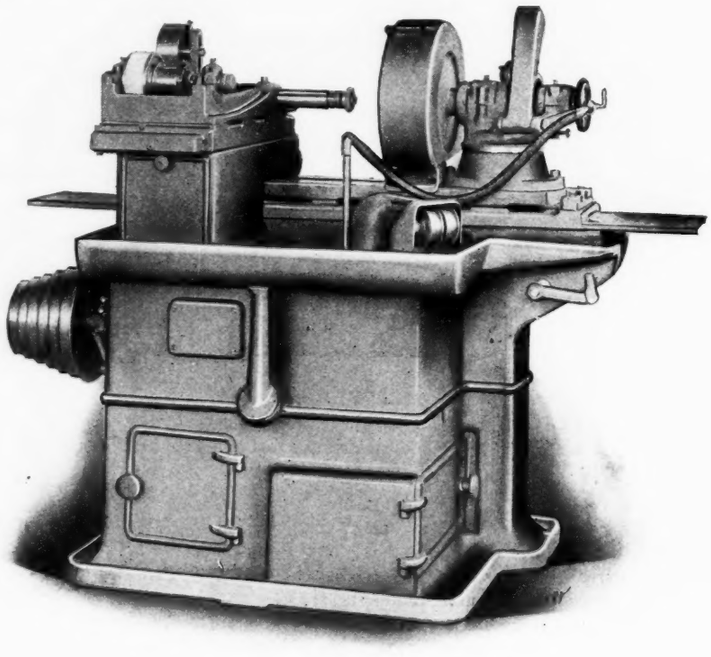


Fig. 2. Rear View of Brown & Sharpe Internal Grinder

The wheel-stand and slide are both of heavy, rigid construction, capable of resisting vibrations which would cause inac-

curacy in the work. The wheel-stand swivels, thus permitting the spindle to be set at an angle when grinding the faces of cutters or automobile gears. This feature is also convenient when a hole has been ground, and it is desired to grind the face of the work before removing it from the machine. The ways of the wheel-stand slide are long to insure alignment, and are amply proportioned to resist vibrations. A transverse movement of the slide is obtained through a worm and wheel, actuated by a handwheel at the front of the machine. When it is desired, an automatic cross-feeding mechanism, similar to that found on all Brown & Sharpe universal and plain grinding machines, can be furnished.

Headstock

The headstock is of a rigid design and is firmly fastened to the swivel table by means of bolts that slide in a T-slot. It swivels and can be set at any required angle, the amount of adjustment being indicated by graduations on the base. The spindle is hollow and runs in bronze boxes provided with means of compensation for wear. It can be locked in position when removing the faceplate, chuck, or an attachment. Over the spindle pulley there is a belt tightening device consisting of a small pulley mounted on a bracket that can be drawn forward or pushed back by means of the handle shown. The forward adjustment puts the driving belt in tension and causes the spindle to revolve and drive the work. When the idler is swung back, the spindle can be quickly brought to a stop for changing the work, or it can be revolved easily by hand when centering a piece. A range of twelve work speeds, varying from 40 to 340 revolutions per minute are provided.

Sliding Table

The sliding table is of rigid construction and its bearing surfaces are scraped to fit the ways on the bed which are aligned with master straightedges. The travel of the table is automatic and entirely independent of the speeds of the work and wheel. It is controlled by adjustable dogs on the front of the table that operate against a reversing lever in the usual manner. The dogs can be raised and the table run beyond the reversing points without disturbing the adjustment, which is a valuable feature when withdrawing the work from the wheel. When the work is finished the trip dog nearest the wheel is raised; the table then moves to the left until the power feed automatically disengages. The table can then be moved farther away by the large handwheel shown. After a new piece of work is inserted, the table is moved up by means of this handwheel until the work nearly reaches the grinding wheel, when the power feed automatically engages again.

Provision for Wet Grinding

The soda water for wet grinding is pumped from a tank located in the bed and is fed to the wheel through the hollow work-spindle. The pump consists of a simple fan, revolving in a case, and, as it is immersed at all times, no packing is required. The tank is readily accessible for cleaning. The hood or water guard shown on the machine is furnished for covering the work.

In other details, the construction of this machine differs but little from that of the Brown & Sharpe universal grinding machines. The swivel table, however, pivots on a stud located beneath the headstock. This gives a long leverage from that point to the end, thus enabling very fine adjustments to be made when setting to grind straight or when adjusting to an exact angle for taper work, after the headstock has been set as closely as possible by the graduations on its base. There are six changes of table feed, varying from 15 inches to 48 inches per minute. The equipment furnished with the machine is shown about the base in Fig. 1. The overhead works, which are not shown, are also included in the equipment.

WALKER SURFACE GRINDER

The Walker Grinder Co., Worcester, Mass., is building an improved design of "single-stroke" surface grinder which is adapted for grinding concave as well as flat surfaces. This machine is of the cup-wheel type and has a heavy column on which are mounted upper and lower vertical slides. The upper slide carries the grinding wheel, and the lower slide has a rotary magnetic chuck on which the work is mounted. When the machine is in operation, the wheel is fed down against the work until the latter is finished to the required thickness. The wheel slide is fed against a positive stop and the thickness of the work is varied by adjusting the lower slide which is equipped with a vertical feed-screw. This screw is operated by the large handwheel (seen at the left of the slide) which is graduated in thousandths of an inch. When this adjustment of the lower slide is once made, it is not changed for successive operations except to compensate for wheel wear. The feeding movement of the grinding wheel is effected by the hand lever seen at the right of the wheel slide. This same lever also controls the starting and stopping of the work spindle, the switching on or off of the magnetizing current for the chuck, and it also controls the de-magnetizing current for neutralizing the residual magnetism always found in a magnetic chuck after the electric current has been switched off.

All of the power movements for this machine are derived from a horizontal shaft at the rear on which are mounted

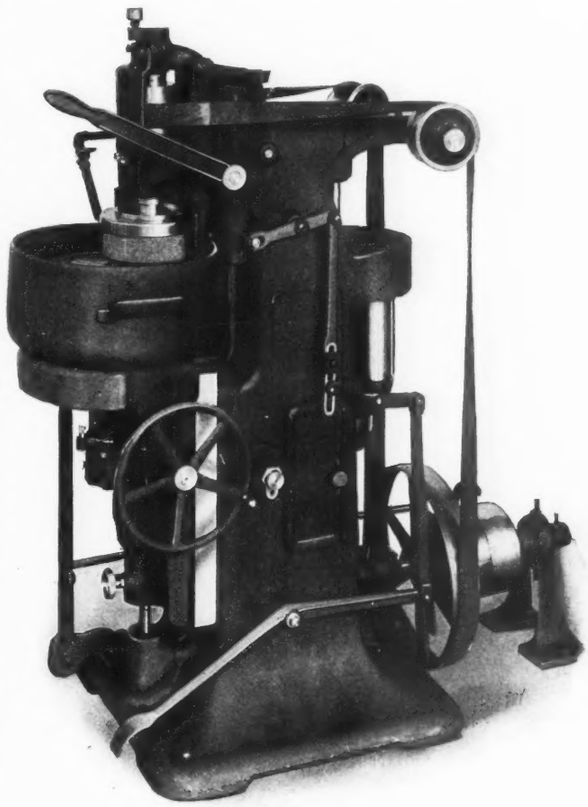


Fig. 1. Walker Surface Grinder

tight and loose pulleys. The wheel spindle is driven independently by a quarter-turn belt which passes over idlers as shown. The spindle pulley is wide enough to permit the required vertical movement of the slide. The work table is driven from the drum pulley seen at the rear of the column. This pulley receives its motion through gearing from an intermediate vertical shaft which, in turn, is driven by a quarter-turn belt connecting with the inner end of the horizontal driving shaft. The drum pulley is also wide enough to permit the necessary vertical movement of the lower slide. The wheel slide is counterbalanced by a weight inside the column, so that when the operating lever is thrown back, the slide returns to its upper position, thus leaving plenty of room under the wheel for placing or removing work. The link and lever connections seen at the side of the column, connect the wheel slide with a jaw clutch inside the work-table driving drum, and disconnect the latter from the shaft on which it is mount-

ed, when the wheel slide is in the upper position. By this means, the work spindle is automatically stopped whenever the wheel is raised from the work. It is sometimes advisable to clean the chuck face while in motion and, in such a case, the drum-clutch operating mechanism may be disengaged, thus giving an independent control of the work spindle through the foot lever seen at the base of the machine.

When this machine is to be used for concave grinding, the knee supporting the work table is tilted to the required angle. The knee is separate from the slide and has an overlapping ledge at the top, on the outer corners of which are set-screws. These set-screws provide means of correct alignment in one direction and form pivoting points. The tilting movement is effected by the knurled screw seen near the lower end of the knee. The latter is held against the slide by four cap-screws which have located quite near them, four adjusting set-screws. These set-screws are permanently set for aligning the knee, but can be re-adjusted at any time if necessary. The knee has an adjustment of two degrees and can be quickly reset in a level position without re-aligning.

Work having a concave surface is not held directly against the magnetic chuck, but on an auxiliary plate. The magnetic power of the main chuck is transmitted through this auxiliary plate, the upper surface of which is shaped to suit the work. The use of the auxiliary plate in connection with the grinding of a milling saw is illustrated in Fig. 2. After the saw is ground concave on one side it is held for grinding the opposite side on a plate having a convex face. If the saw were held for grinding the last side, against the flat face of the regular chuck, it would be pulled down in the middle, thus making it impracticable to concave both sides alike. Fig. 3 shows the method of grinding such work as dies, disks, etc., and Fig. 4 illustrates how piston-rings or similar parts are held. Fig. 5 shows how a number of small washers can be ground at one setting. These washers are separated by a perforated iron or brass disk, which acts as a retainer and holds the parts in the required position over the poles of the magnetic chuck. Fig. 6 illustrates how parts can be located on a chuck for multiple grinding, so that they support each other, thus making it unnecessary to use stays. These different views are shown to indicate, in a general way, how various kinds of work is ground on a machine of this type.

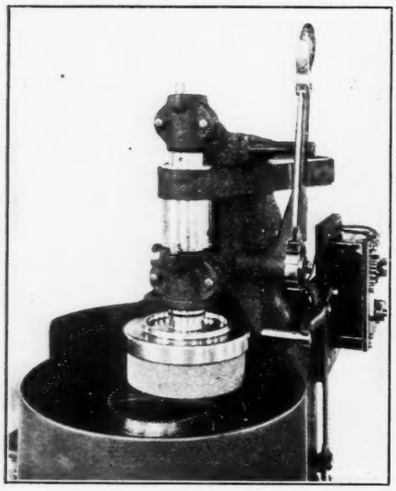


Fig. 2. Grinding a Concave Saw

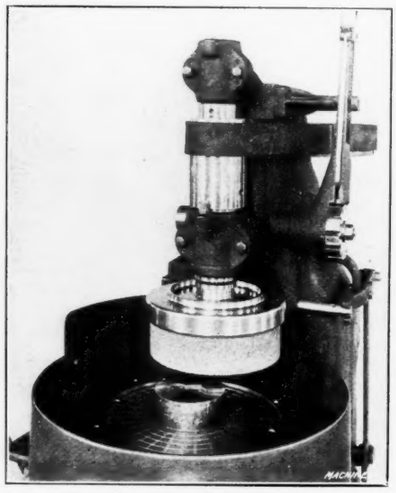


Fig. 3. Grinding a Die

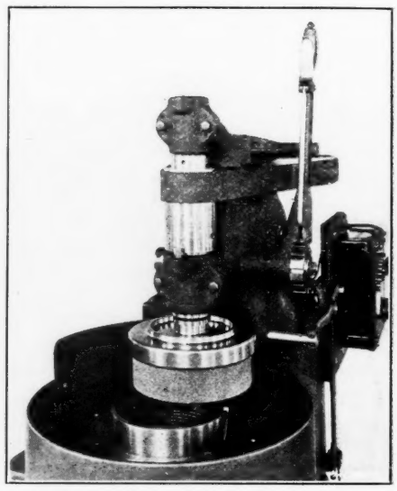


Fig. 4. Method of Holding Piston-ring

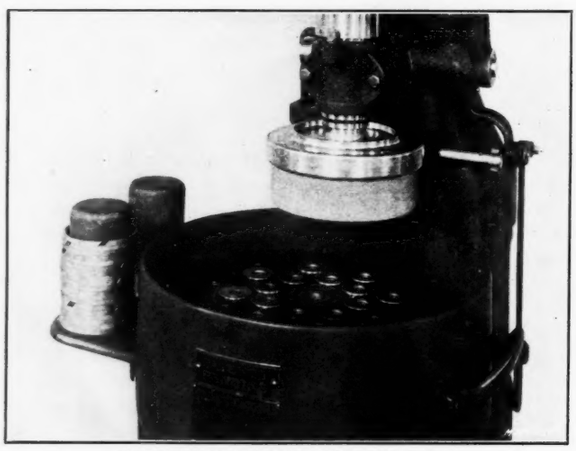


Fig. 5. Multiple Grinding of Small Washers

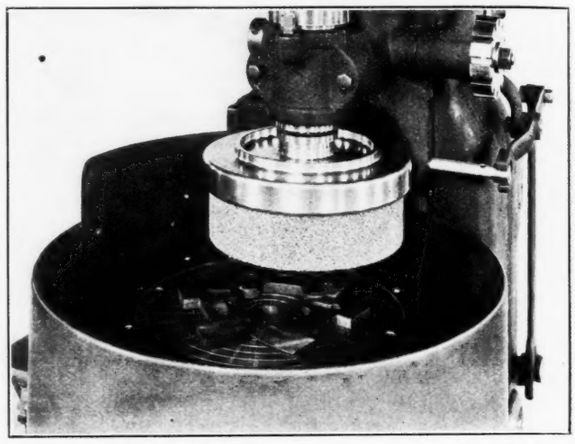


Fig. 6. Small Parts placed on Chuck so as to support Each Other

BAKER BROTHERS AUTOMATIC DRILLING MACHINE

Baker Bros., of Toledo, Ohio, have brought out a new type of drilling machine designed to reduce the idle or non-productive period connected with drilling operations. The maximum time required for drilling many classes of work is not consumed while the drill is passing through the material, but while the operator is placing the work in position, advancing the tool to the work through the jig bushing or clearance space, engaging the feed, withdrawing the tool and removing the work. After considerable study and experimenting, this company has developed a machine to perform these operations automatically—as far as the movement of the drill-spindle is concerned—and in a minimum of time. This machine, which is illustrated in Figs. 1 and 2, is so simple in construction that changes for different classes of work can be made quickly. The spindle is fed to the proper depth and returned by means of a cam which gives a powerful feed and a quick return movement. The feed also has a dwell at the end of the downward movement, which adapts the machine for accurate facing operations.

Either a plain work-table or one having an automatic index-

ing movement is provided. The automatic table is intended for work which is comparatively small, thus permitting a number of parts to be held in a suitable fixture around the periphery of the table, as shown in Fig. 2. As the forward and return movements of the drill spindle are automatic, the operator simply inserts new blanks and removes those that are drilled. The automatic indexing motion takes place as soon as the spindle is withdrawn and rotates the table to the next position, thus bringing a new piece of work under the drill or other tool. The period required for withdrawing the tool and indexing the table varies from two to three seconds. Change-gears are provided for indexing the table any required number of divisions from five to eighty. As the table can be adjusted in or out, holes can be drilled on circles of any radius within the capacity of the machine, by providing the proper change-gears for the indexing movement. The standard machine will drill holes in circles varying from four to twenty inches in diameter. A scale is provided which shows the diameter of circle on which the drill is set for any position of the table. When this machine is used for chuck work, the table usually has from six to eight chucks, and all the workman has to do is to insert and remove the work, as the machine itself requires no attention other than to see that the tools are kept sharp. If a drill should break, the machine can be stopped instantly.

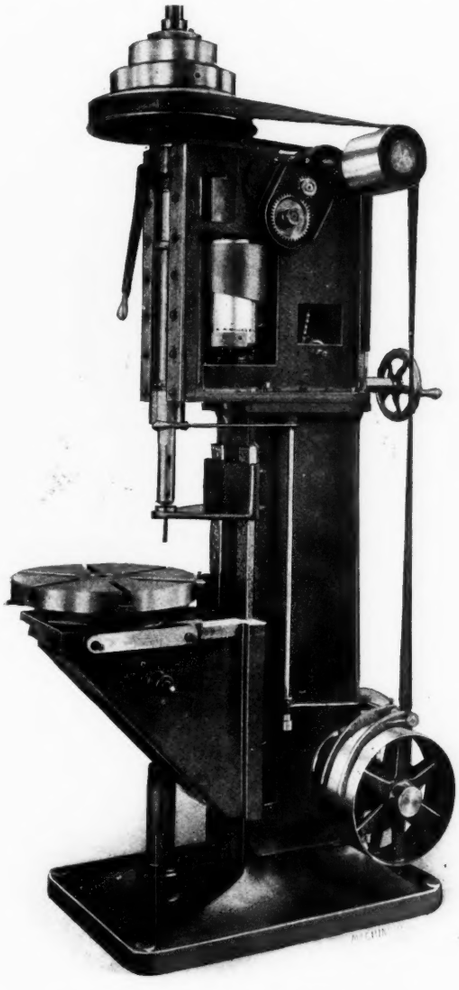


Fig. 1. Baker Bros. Automatic Drilling Machine

In case it should be desirable, the machine can be made to skip any number of chucks when indexing.

When a plain table is used, the operator places the work under the drill-spindle and trips the machine by a foot-lever, the same as he would a punch press. The spindle then advances and the drill passes through the work, after which the spindle returns quickly to its upper position. The operator then removes the finished piece of work, places another blank in position and trips the foot-lever as before, which causes the spindle again to feed down and return automatically. As the machine is entirely controlled by the foot-lever, the operator can use both hands for inserting and removing the work, thereby securing a very rapid production. The plain table is used for work which, because of its shape or size, could not be handled on a machine of the automatic indexing type, such as is shown in the accompanying illustrations.

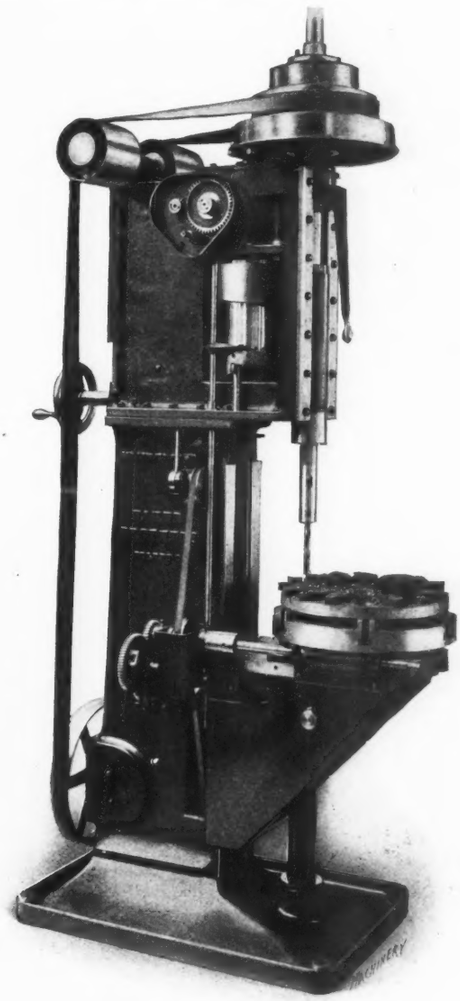


Fig. 2. View of Baker Bros. Drilling Machine showing Table Indexing Mechanism

This machine has a capacity for drilling 1-inch holes in steel when using high-speed drills. The automatic indexing type will drill ¾-inch holes through a piece of cast iron ¾ inch thick, at the rate of eight holes per minute. The spindle is mounted in a bronze-bushed slide which operates on carefully scraped ways. The revolving cam-drum, which imparts a feeding movement to the spindle, acts against a roll attached to the spindle saddle. This cam, in addition to "slip" change-gears, gives the required feed variations. One cam is provided with each machine.

The spindle has a vertical movement of 6 inches. It is made of high-carbon, hammered crucible steel and has a minimum section of 1¾ inch. The end is bored to a No. 3 or 4 Morse taper. There are six spindle speeds ranging from 200 to 800 revolutions per minute, the changes being obtained by means of the three-step cone pulley shown, and a two-speed countershaft. The idler pulleys at the rear are mounted on a vertical slide which can be adjusted to align the pulleys with different steps on the spindle cone, by means of the handwheel seen at the rear. The spindle is driven by a 2-inch belt and the distance from the center of the spindle to the frame is 8 inches. All the running bearings of this machine are equipped with ball bearings. The machine can be arranged for either motor or belt drive.

NEW BRITAIN SCRAPING STAND

The stand shown in the accompanying illustrations is used for holding work while scraping the bearing surfaces. This stand is especially useful in connection with the scraping and fitting of dovetail ways or bearing surfaces which are at an angle with the face of the work. The table to which the parts are clamped can be adjusted to hold the work in a horizontal position, or it may be tilted to locate the surface being scraped in a more convenient position for the workman, as indicated in Fig. 2.

Fig. 1. New Britain Scraping Stand

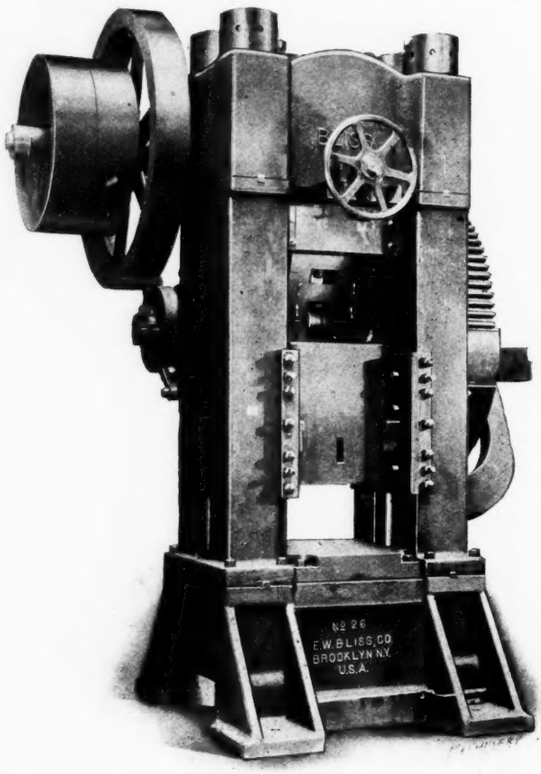
The table is locked in position by means of hinged clamping levers which are permanently attached to the stand. The table may be inclined to any angle up to 90 degrees. The face of the table is 16 by 30 inches. The work is held in position by means of bolts that engage T-slots cut in the table face. The height of the table can be varied from 28½ inches to 34½ inches. This adjustment is effected by means of a "quick-pitch" screw located within the column. After the table is raised to its extreme height, it still has a bearing on the column so that it cannot be accidentally turned out of the base. The vertical adjustment permits the work to be held at the most convenient height for the workman. This scraping stand is made by the New Britain Machine Co., 64 Bigelow St., New Britain, Conn.

Fig. 2. Stand set for Scraping Angular Surfaces

BLISS "KNUCKLE-JOINT" PRESS

Power presses of large proportions and great capacities are being used increasingly in connection with many manufacturing operations, owing to the fact that many articles can be produced more economically and uniformly in a press than by the methods formerly employed. The E. W. Bliss Co., 5 Adams St., Brooklyn, N. Y., is now building a new line of knuckle-joint presses, one size of which is shown herewith. These presses are used for heavy stamping and embossing operations on steel, brass, copper, silver, Britannia, etc., and they are particularly adapted for embossing operations in the manufacture of medals, coins, jewelry, etc. The toggle-joint gives a powerful movement to the slide at the end of the stroke when the work is being done. A comparatively slow movement is also obtained at the end of the stroke which is desirable when it is necessary to have the metal flow while under pressure, as in embossing.

This machine is capable of exerting a pressure of 800 tons. The toggle links are placed above the slide in the same position as the pitmans of an ordinary crank press, and they are operated by a crankshaft in the rear of the press. This construction permits the use of positive knockout attachments in the bed and cross-bar knockouts in the slide. The powerful jaw clutch on this machine has three engaging points and is operated by the foot-treadle seen at the right. The necessary adjustment for dies and pressure is obtained by a taper wedge adjustment. The position of this wedge is changed by means of a screw, which, in turn, is operated by the handwheel shown.



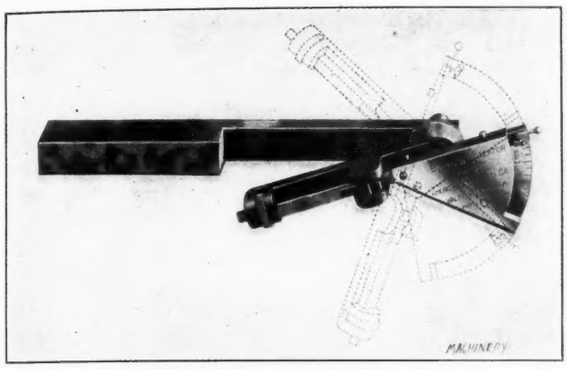
Large Toggle-joint Embossing Press

This press is of the tie-rod construction, the bed and crown-piece each being separate castings. The side housings, which take any side strain and provide bearing surfaces for the slide and crankshaft, are also separate and of box section. Four large tie-rods pass through the side housings and take the entire strain when the press is at work. This construction not only prevents breaking the frame, but also provides a means for releasing the press should it become stalled on its center, as the tie-rods may be heated and expanded through suitable openings provided. The distance between the uprights of the press is 28 inches; the stroke of the slide is 2 inches, and the total weight of the machine is 45,000 pounds.

TEST INDICATOR

A new type of test indicator recently developed for use on a lathe, milling machine or in connection with tool-room work, is shown in the illustration. The instrument proper is very light and sensitive and has a scale with graduations reading to 0.0005 inch. Since these graduations are spaced ⅛ inch apart, a reading of 0.0001 inch can be obtained. As the tool is

mounted on an adjustable holder, it can be set in any direction as indicated by the lines. The position with relation to the work can be varied by an adjusting nut at the end of the tool, and there is an elevating nut for raising or lowering the indicator to bring it in alignment with the center line of the lathe. This indicator, when arranged as illustrated, can be used in an ordinary toolpost, and when the holder is removed, the stem fits the toolpost of any bench lathe or it can be clamped to the spindle of a surface gage in place of the scratch awl or scriber. Direct contact is made with work by



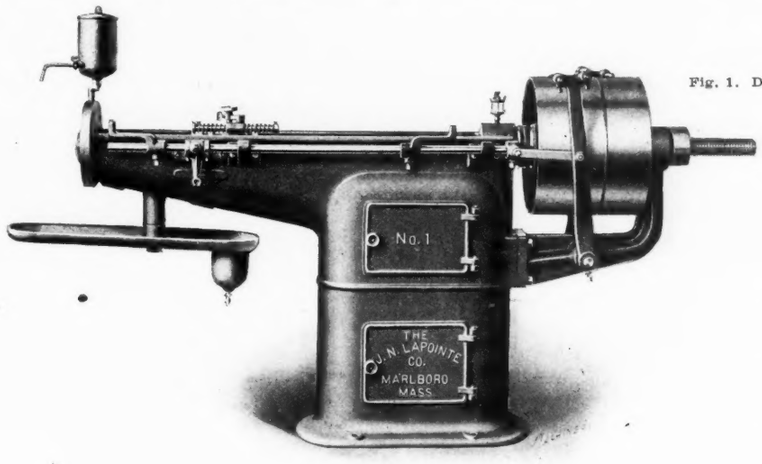
Test Indicator made by American Watch Tool Co.

a small ball point, which, through a system of levers, gives a reading on the scale that is multiplied about two hundred times. The contact point is removable and can be replaced by finer ball points, flats or any special shape required. The working parts of the indicator are all carefully protected from injury by a metal shield. This indicator has been placed on the market by the American Watch Tool Co. of Waltham, Mass. It is an accurate and inexpensive instrument for use in machine shops or laboratories.

LAPOINTE BROACHING MACHINE

A light type of broaching machine has been designed by the J. N. Lapointe Co., Marlboro, Mass., for keyseating comparatively small parts, such as the change- or feed-gears used on various types of machines. This machine is said to cut keyways in work of this kind at the rate of from 150 to 200 pieces per hour. It has a capacity for broaching keyways up to ⅜ inch in width, and usually from two to four parts can be broached simultaneously.

The construction of this machine is very simple. There is a sliding head having a stroke of 40 inches, which is actuated by a 2-inch non-revolving screw. This screw passes through a revolving bronze nut which is inserted in the hub of the driving pulley. Two loose pulleys are mounted on the hub of the tight pulley, this hub acting as a bearing for the driving mechanism. This combination of pulleys and also the belt shifting device, is similar to the arrangement used on planers. The driving belts can be shifted by hand, or automatically by means of adjustable dogs. The rod which carries the stop-dogs, is connected with two swiveling belt-forks which are mounted on a shaft passing through the bracket shown. When the sliding head comes in contact with one of the stop-dogs, either the forward or return belt is shifted onto the tight pulley, thus reversing the movement.



Lapointe No. 1 Broaching Machine

The stroke of the sliding head is varied according to the length of the broaching tools used, by simply changing the position of the stop-dogs. The driving nut is so arranged that it can be removed quickly for replacement, when necessary, by unscrewing a cap at the end of the driving pulley hub. This machine has a ball bearing thrust to eliminate excessive friction and wear on the nut and screw, especially when heavy broaching is being done. The ball bearing reduces the power required for operating the machine. This machine is also adapted for broaching square holes up to ⅝ inch.

DWIGHT SLATE AUTOMATIC DRILLING MACHINES

The multiple-spindle machines illustrated in Figs. 1 and 2 are automatic in that the feeding and return movements of

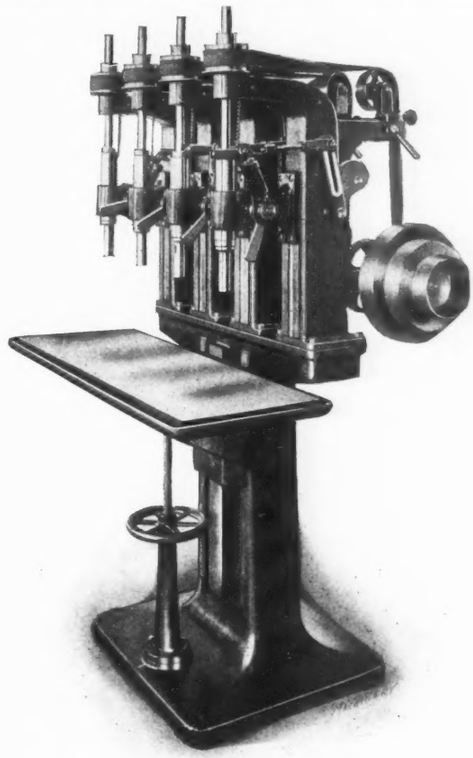


Fig. 1. Dwight Slate Cam-feed Automatic Drilling Machine

the drill spindles are obtained from cams. These cams are mounted on a shaft at the rear and are spaced at equal angles, thus giving the same intervals of time between the movements of each spindle. For example, the cams of a four-spindle machine are 90 degrees apart, whereas the cams of a six-spindle type are 60 degrees apart. When the machine is in operation, the various spindles move progressively and continuously, and the workman's entire time is utilized in loading jigs and removing the drilled parts, so that a very rapid production is obtained.

These machines are of an improved design now being manufactured by the Dwight Slate Machine Co., Hartford, Conn. The machine shown in Fig. 1 has four spindles, and Fig. 2 is a rear view of a six-spindle type. Any number of spindles ranging from two to eight can be furnished. The number that

one man can operate depends, of course, on the time required for drilling the work. The end view, Fig. 3, shows the arrangement of the cam feed. The required movement for each spindle is obtained from an independent cam *C* which engages a roller on slotted arm *A*. The latter is connected to the pinion shaft by rod *B* and the lever shown.

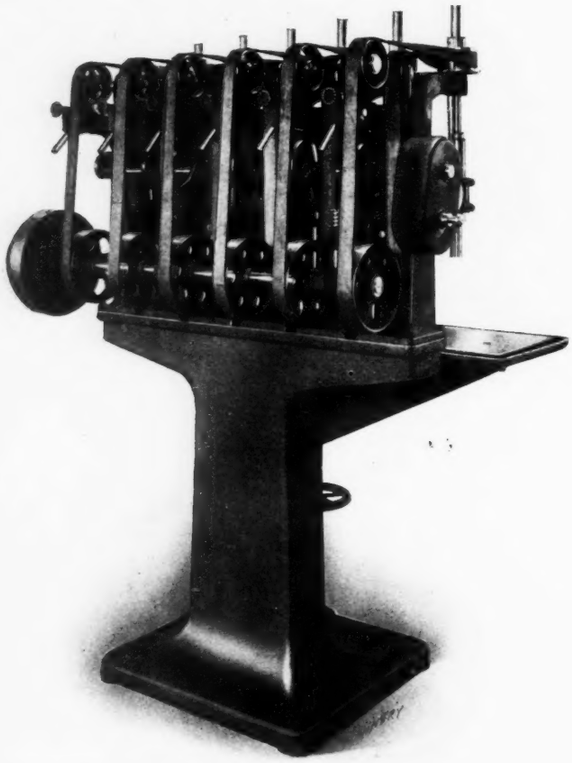


Fig. 2. Rear View of Six-spindle Cam-feed Drilling Machine

The stroke of the spindles is varied for drilling holes of different depths, by adjusting nut *a* on the slotted arm. The position of each spindle can also be adjusted independently for leveling the drill points, by loosening nut *D* and turning the

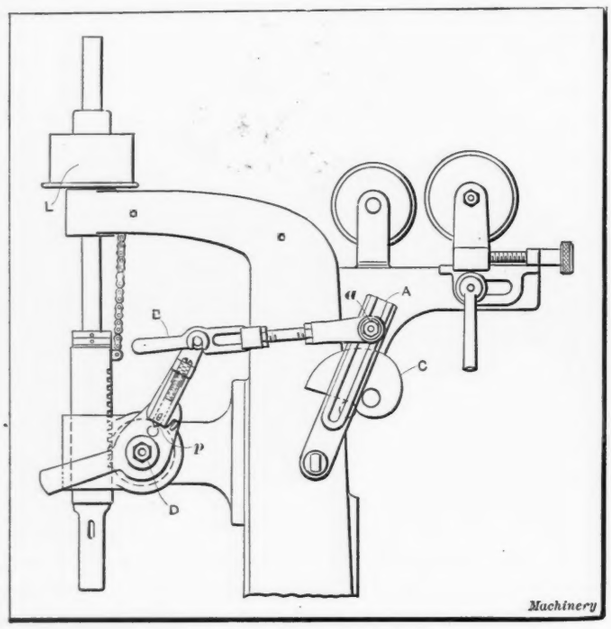


Fig 3. Detail of Cam-feed Mechanism

feed lever with relation to the pinion shaft. The end of this pinion shaft is tapering and fits into a hole of corresponding taper in the hub of the feed lever, which connection enables the adjustment to be made. The feed lever is made in two parts and is equipped with a safety device for stopping the feed in case of an overload at the drill point. The safety stop consists of a hardened, adjustable spring-plunger *p* which is inserted in the upper half of the feed lever and engages a notched stud attached to the lower half. If an overload occurs, plunger *p* is disengaged from the stud, thereby protecting the feed mechanism and preventing the breaking of drills to a large extent. The tension on this plunger can be varied for drills of different diameters. In case it is desired to feed one of the drill spindles by hand, this can be done by disengaging link *B*.

As the amount of feeding movement is limited to the throw of the feed lever, this machine is restricted to the drilling of holes not exceeding 1½ inch in depth. The cam-shaft is driven from the main shaft through worm gearing and the feed change mechanism seen to the right of the machine in Fig. 2. This gear box gives three feed changes which are obtained by shifting a small pull-pin. There are also three spindle speeds obtained by the three-step driving cone pulley. The spindle driving belts have adjustable idlers at the rear for varying the tension, and the spindle belt pulleys are equipped with oil reservoirs and an ingenious method of providing continuous lubrication.

The work table of this machine is securely locked to the column by a narrow gib located on one side of the central

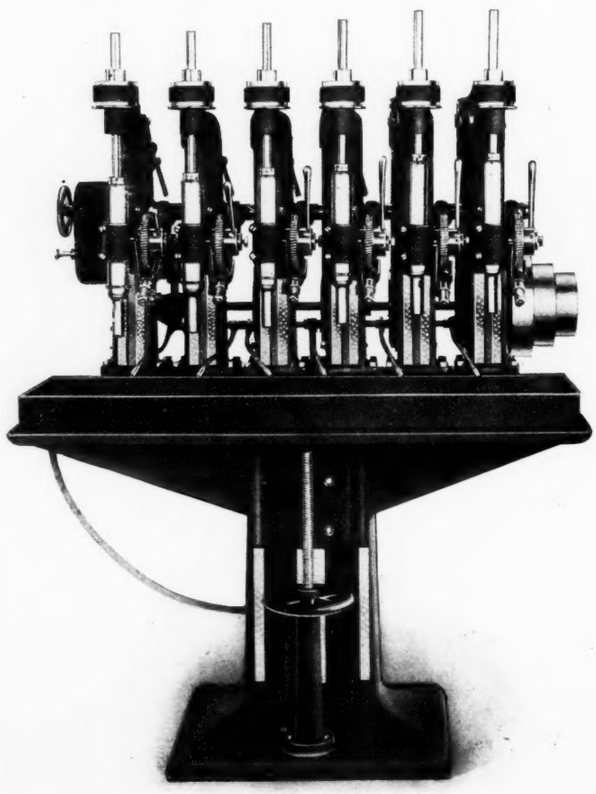


Fig. 4. Automatic Drilling Machine with Worm Feed

dovetailed way seen in Fig. 1. When this gib is drawn outward by a stud passing through the saddle, the table is clamped tightly against the outer bearing surfaces shown, and it is also securely locked to the central dovetailed way. The elevation of the table is effected by the screw and handwheel shown. This machine is especially adapted for drilling small duplicate parts such as are used in the manufacture of locks, light hardware, small tools and similar parts.

Fig. 4 shows another multiple-spindle machine of the same type but equipped with a different feeding mechanism. The arrangement of this feed is shown in Fig. 5. The feed movement is derived from a back shaft *U*, which is driven from the main shaft through a change-gear box, the same as with the cam-feed design. The feed worm *F* is supported and held in engagement with worm-gear *R*, by a latch-arm *A* which nor-

mally engages a supporting stud *I*. The adjustment of the automatic feed trip for drilling holes of any depth between 0 and 5¼ inches, is obtained by setting the adjustable ring *B* in the proper relation with the pinion shaft. This ring has a projecting lug, as shown, which disengages latch-arm *A* and throws out the feed. The distance that the projection on ring *B* travels before disengaging the latch, determines, of course, the depth of the hole drilled. The screw *N* and shoe *K* provide convenient means for securely locking ring *B* to pinion shaft *L*. The stop-pin *P* determines the maximum adjustment of ring *B*.

This machine also has an automatic safety release in case of an overload, which operates as follows: Worm *F* is keyed to rotate with its shaft, but is free to slide longitudinally. Under a normal load this worm is held in the operative position with respect to worm-gear *R*, by means of a ring *C* and compression spring *D*. When overload occurs, the worm moves longitudinally against the tension of compression spring *D*, and as the

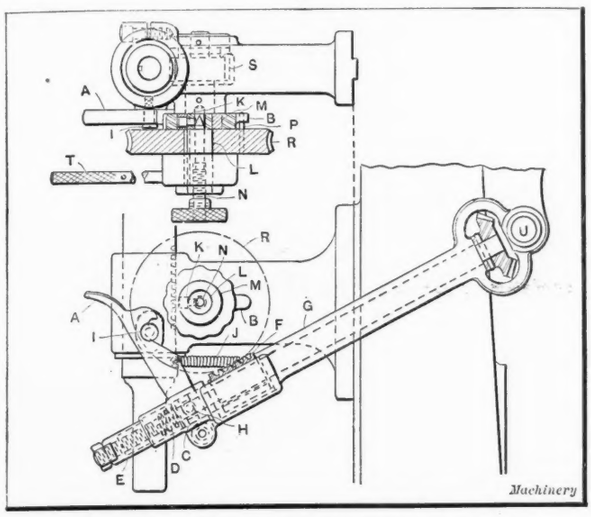
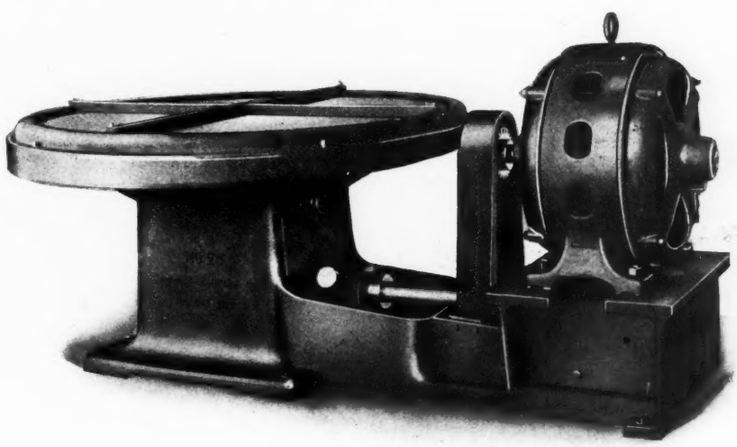


Fig. 5. Feed Mechanism of Machine illustrated in Fig. 4

worm is connected to latch *A* through the ring *C* and pin *H*, this longitudinal movement results in disengaging the feed. The tension of spring *D* can be varied for drills of different diameter, by cap *E* and the locking nut shown. The feed can be stopped at any time by throwing out latch *A*, and it is engaged by simply lifting the worm-shaft supporting arm *G*, which causes the latch to hook over stud *I*.

A multiple-spindle machine equipped with the worm feed, is

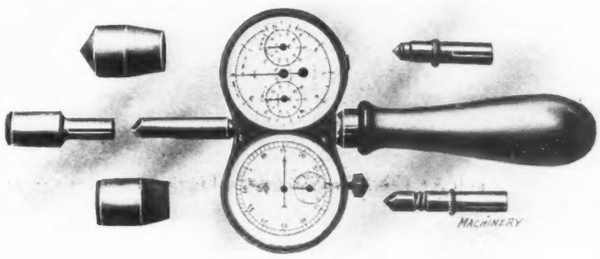


Gardner Vertical-spindle Motor-driven Disk Grinder

recommended when the drilling is comparatively deep, and, especially, for work which cannot be quickly inserted in or removed from the jigs. On the other hand, the cam-feed machine is adapted to that class of work which is quickly drilled and easily jigged.

SCHUCHARDT & SCHUTTE TACHOSCOPE

The instrument shown herewith is known as a "Tachoscope" and consists of a revolution counter and a non-magnetic, precision stop-watch, which are so connected that they operate simultaneously the moment a slight pressure is applied to the center spindle. As soon as the pressure is released, both the revolution counter and watch stop at the same time, thus indicating on the dials shown, the number of revolutions made



Combined Revolution Counter and Stop-watch

by whatever is being tested, and also the time elapsed. The small pointer on the watch dial records up to thirty minutes and then repeats, and the duration of the test is indicated in minutes, seconds and fractions thereof. The revolution counter has three pointers which indicate from 1 to 100, 100 to 1000 and 1000 to 10,000 revolutions per minute, respectively. This instrument can be used for right- or left-hand rotation and no adjustment or setting is required. The appearance of either a red or black disk on the counter dial, indicates whether right or left rotations are being counted, and the figures on the dials which correspond in color with this disk, are the proper ones to use. The counter and also the stop-watch, can be set back to the zero position instantly. The movements of the stop-watch and counter are said to equal in precision those used in high-grade time pieces. This instrument, which has been placed on the market by Schuchardt & Schutte, Cedar and West Sts., New York, is especially recommended for testing rapidly revolving parts and it can be used for speeds up to 30,000 revolutions per minute.

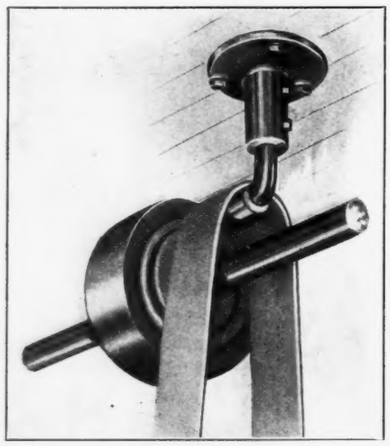
GARDNER MOTOR-DRIVEN DISK GRINDER

The large vertical spindle type of disk grinder which is built by the Gardner Machine Co. of Beloit, Wis., and was described in detail in the September, 1911, number of MACHINERY, is now equipped with a motor drive. The motor is mounted on an extension of the base and forms an integral part of the machine, as shown by the accompanying view. A 15-horsepower motor is used, and connection is made with the main shaft of the grinder by a silent chain. This main shaft, in turn, drives the disk wheel spindle through bevel gears which are fully enclosed and run immersed in oil. A guard covers the chain and gears as shown. The starting box for the motor is attached to the rear of the base and does not show in the illustration. The pedestal for the motor is made to accommodate any standard make that is specified.

When these machines are installed in plants having no dust exhaust system, an exhaust blower is furnished. The pulley for driving this blower is attached to the main driving shaft, midway between the shaft collar and the silent chain gear. The disk wheel is driven at 500 revolutions per minute, and is 53 inches in diameter. This type of grinder is also made for a belt drive, from either overhead or underneath. The motor-driven type is often more convenient when it is desired to place the machine under a hoist or crane-way. The complete weight of the machine is 4500 pounds.

SAFETY BELT-HANGER

The Universal Stamping Co., 47 Poultney St., Buffalo, N. Y., is now manufacturing a safety belt-hanger which is designed to prevent the accidents caused by belts winding up on the shaft when they are thrown on or off the pulleys. This hanger consists of a cast-iron bracket which is fastened to the ceiling or shaft-hanger support, by three lag-screws or bolts. The hanger proper is made of steel tubing bent at right angles on the lower end. The horizontal part thus formed carries a roller which is held in place by a small casting driven in the end of the tube. The hanger is located over the center of the shaft, and on whichever side of the pulley the belt is usually thrown off. The supporting roller should be about one-half inch below the rim of the pulley. The end of the roller should also be close to the side of the pulley. When a belt is thrown off it runs onto the roller, and, if the other end of the belt is also thrown off the driven pulley, the belt will hang free from the shaft, as shown in the illustration. When a belt is being placed on the revolving pulley, it is first engaged with the stationary driven pulley, after which it is slipped onto the driving pulley by using an ordinary belt pole. As the belt is held close to the pulley rim by this hanger, it can be put on easily. This belt-hanger is made in three sizes for belts up to 6 inches in width.



Safety Belt-hanger

CHAMPION MOTOR-DRIVEN LATHES

The method of applying a motor drive to the 12-, 14-, 16, and 18-inch lathes built by the Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, Ohio, is shown in Figs. 1 and 2.

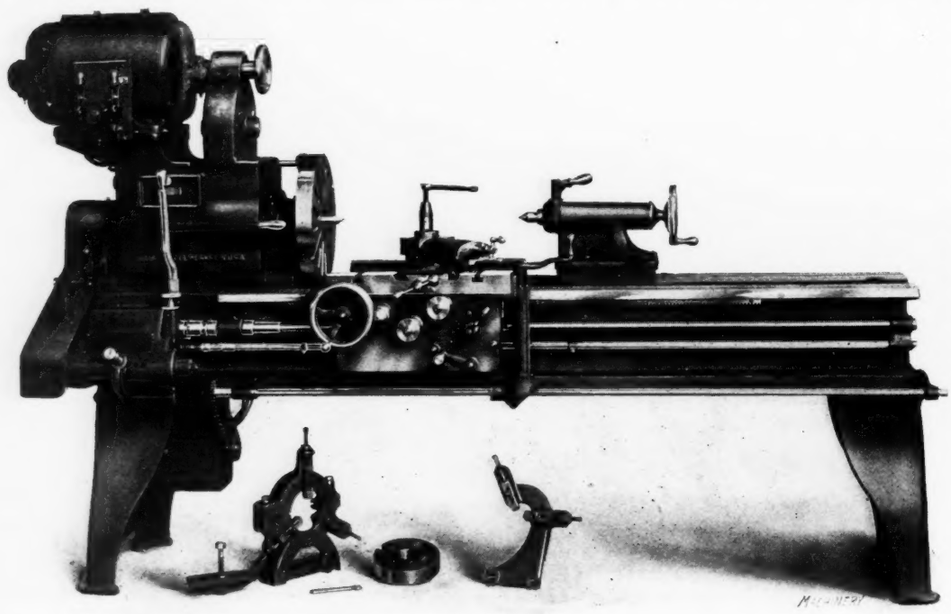


Fig. 1. Motor-driven Lathe built by the Champion Tool Works Co.

The power is transmitted from the motor to the lathe spindle as follows: A steel pinion mounted on the motor shaft, meshes with a raw-hide intermediate gear which makes the drive practically noiseless. This raw-hide gear drives a friction gear which runs freely on the spindle sleeve. Keyed to this sleeve there is a friction controlled by the horizontal lever seen in front of the headstock, and by means of this lever, the lathe can be stopped or started at will, independently of the motor. The drive from this point to the spindle is either direct through the face gear to which the friction can be connected by means of a locking pin, or through either one of the positive-clutch, double back-gears which are controlled by the vertical lever shown. These three mechanical changes in the headstock, in addition to those obtained by the three to one variable-speed direct-current motor, give a wide range of progressive spindle speeds. The spindle speeds vary (approximately) from 12 to 400 revolutions per minute, and the convenience of the control enables these changes to be obtained quickly and with little effort on the part of the operator.

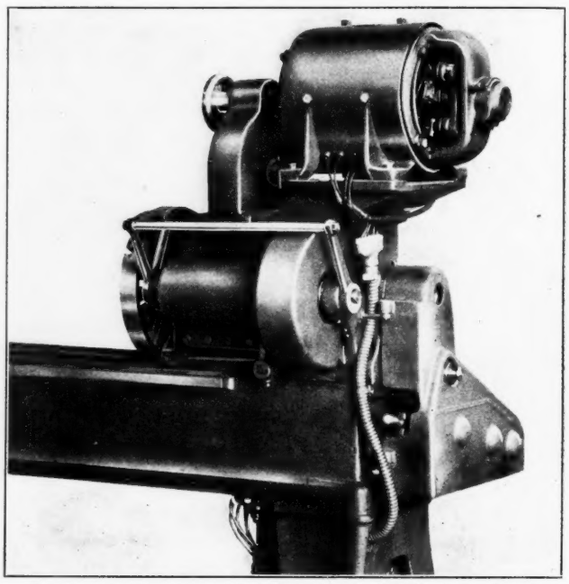


Fig. 2. Rear View showing Headstock End of Motor-driven Lathe

The speed of the motor is regulated by a drum-type controller located under the headstock end of the lathe. This controller is operated by the crank handle seen at the right of the apron. The connection between this handle and the controller is made through bevel gears, a splined rod and the chain and sprocket wheels shown. A handwheel on the outer end of the motor shaft, enables the operator to revolve the lathe spindle by hand, when this is necessary in connection with the chucking or inspection of work. Any standard make of motor having a speed variation of from 500 to 1500 R.P.M., can be used and the following sizes are recommended: For a 12-inch lathe, 1 horsepower; 14-inch lathe, 1 horsepower for medium duty, and 2 horsepower for heavy duty; 16-inch lathe, 2 horsepower; 18-inch lathe, 3 horsepower. These lathes can also be furnished for motors of the alternating current type.

The back-gears on this machine are so arranged that a change from the single to the double back-gear can be made without stopping the lathe. As previously stated, this change is effected by the vertical lever seen in front of the headstock. These gears have a positive internal key clutch, and the change

from fast to slow or *vice versa*, can be made quickly without shock or jar. The feeding movement of the lathe can be reversed either from the apron or headstock, and the longitudinal feed can be disengaged at any predetermined point by automatic stops. There is a chasing dial for thread cutting and an interlocking device to prevent engaging the screw and rod feed simultaneously. The quick change gear box gives forty changes for feeding and threading without removing any gears. Eight of these changes are obtained by a single lever, and one movement of a push-pin varies the entire range. All the gears are carefully guarded as will be seen by referring to the rear view, Fig. 2.

The 16-inch lathe has a swing of 17⅛ inches over the bed and a swing of 11⅝ inches over the carriage bridge. It has a capacity for cutting screws having from 2 to 56 threads per inch, including 11½ pipe thread. The ratio of the double back-gears is 8 1/3 to 1 and 3 to 1, respectively. A double friction countershaft, large and small face-plates, steady- and follow-rests, wrenches, etc., are included in the equipment. A taper attachment, chucks, chuck-plates, a draw-in attachment, spring collets, oil pan, pump, turrets for the carriage or bed, and similar equipment, can be furnished extra if desired.

SLOCOMB INSIDE MICROMETER SETS

The J. T. Slocomb Co., Providence, R. I., has recently placed on the market inside micrometer calipers in sets, contained in morocco-covered velvet-lined cases. Some of these sets contain only inside micrometers, and others have, in addition, regular outside micrometers, as shown in the accompanying illustrations. The set seen in Fig. 1 contains two inside micrometer handles, with two points for each handle for measuring diameters from ½ to 2 inches by thousandths of an inch. The set shown in Fig. 2 has one inside micrometer handle with two points for measuring from ½ to 1 inch, and it also contains a 1-inch outside micrometer. There are six sets, in all, which differ in the combination and number of tools they contain.

The form of the inside micrometer permits it to be used for measuring throughout the depth of any hole within its capacity and it is adapted for either tool-room or general machine shop work. This micrometer is a direct-reading instrument and can be set to given dimensions without using an outside micrometer. The inside micrometer is made in two sizes and each size has two measuring screws which are fitted with individual nuts graduated to read to thousandths of an inch. Adjustments for different diameters are obtained by turning these graduated nuts and the caliper is locked in any position by simply turning the knurled handle. The adjusting screw is prevented from turning with the nut by V-grooves engaged by a V-pointed spindle at the side, which is tightened by the handle and forms the lock. The V-groove has 1/10 inch graduations, which appear above the nut after every fourth revolution, thus giving a direct and continuous reading in addition to that obtained by finer graduations on the periphery of the nut.

Fig. 1. Inside Micrometer Set with Capacity for measuring from 1-2 to 2 Inches

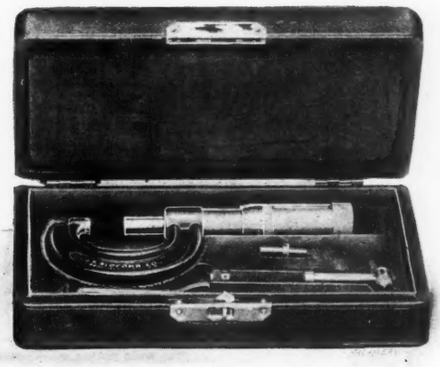
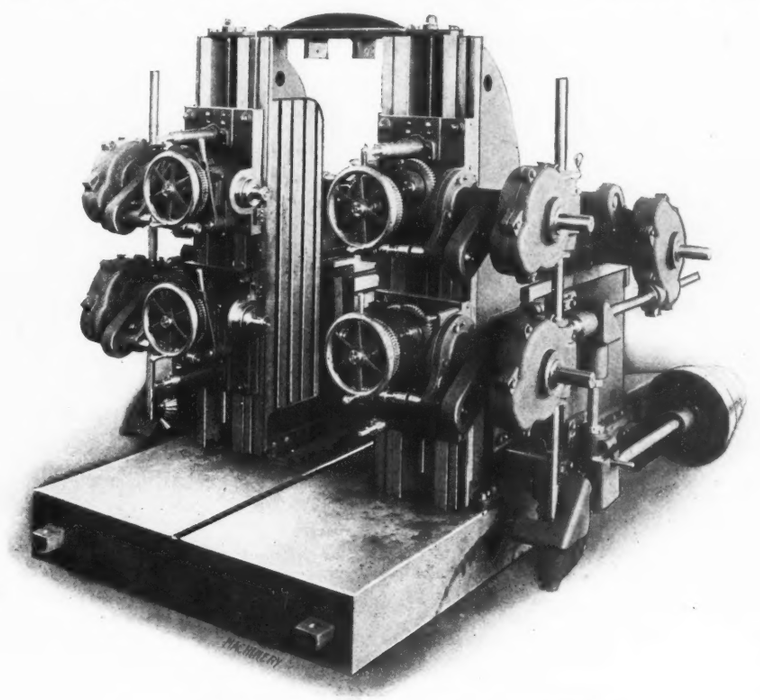


Fig. 2. Combination Set containing Inside and Outside Micrometer

BEAMAN & SMITH SIX-SPINDLE BORING MACHINE

The boring machine illustrated herewith is a special design built by the Beaman & Smith Co., Providence, R. I., for boring and reaming heater sections. This machine has a heavy base or platen upon which are mounted two uprights. On the front face of each upright, there are two adjustable saddles, each of which carries a horizontal spindle. At the rear of the upright, there are horizontal beds and each bed also has a saddle and horizontal spindle, making six spindles in all. The work is held in a jig and it is bored or reamed simultaneously from both sides, by the different spindles, thus giving a rapid production.



Beaman & Smith Special Six-spindle Boring and Reaming Machine

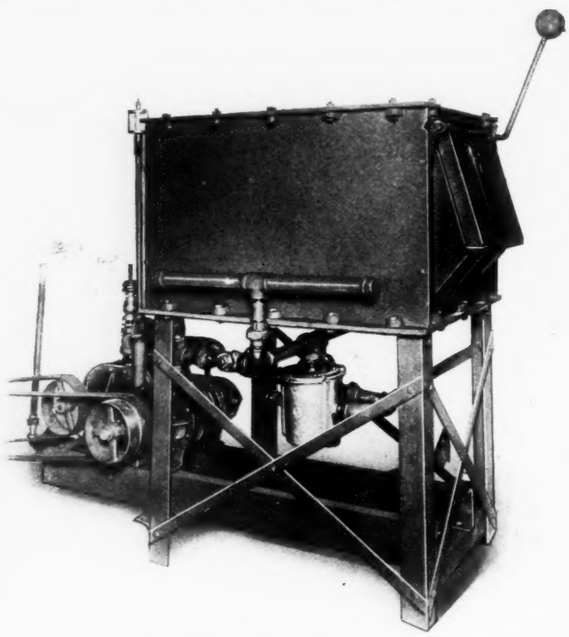
The platen is provided with a track on which a jig holding the work is rolled into position. Two jigs are required, so that one can be loaded or unloaded, while the other is in the machine. The spindles in each upright are driven in unison, and those on the beds at the rear are independent. All the spindles have a horizontal movement of 11 inches in their respective heads. There are four speeds ranging from 15½ to 32 revolutions per minute. The feeds for the spindles are automatic and vary from 1/64 to 1/16 inch per revolution. Variations of feed are obtained by change gears. Each side of the machine is driven independently by 5-inch belts which operate on four-step cone pulleys at the rear. The driving gears have a ratio of 14 to 1.

The spindles are all crucible steel and run in hard bronze boxes. The inner ends of the spindles are fitted to the particular form of cutter required. The platen of this machine is

6 feet wide and 10 feet long. The distance between the uprights is 23½ inches. The minimum distance between the centers of the front spindles is 18 inches and the maximum distance, 49 inches. The minimum and maximum distances between the ends of opposed spindles, are ¾ inch and 22¾ inches, respectively. The greatest distance between the front and rear spindles is 62 inches. The weight of this machine is approximately 31,000 pounds.

CASEHARDENING AND ANNEALING FURNACE

The casehardening and annealing furnace shown herewith is manufactured by the Wisconsin Foundry & Machine Co., Madison, Wis. The principal features claimed for this furnace are: high temperatures with a minimum amount of gas, ease of heat regulation for constant temperatures, and simplicity of operation. The furnace proper has a fire-brick heating chamber, 15 inches wide, 11 inches high, and 30 inches



Casehardening and Annealing Furnace

long. This chamber is thoroughly insulated from the iron shell by air spaces and asbestos board strips. The insulation is said to be so effective that the furnace chamber remains hot after the fire has been out about fifteen hours. The furnace door is easily opened or closed, owing to the ball counterweight provided. Each installation is supplied with two positive-pressure blowers of sufficient size to produce the best results. The air and gas enter, separately and under pressure, a mixer which is seen under the furnace. Here the gas and air are thoroughly mixed, and this mixture passes to the furnace through a single pipe. It is claimed that a temperature of 2500 degrees can be easily obtained. The installation illustrated is equipped with a gasoline priming system which is used to advantage in starting the furnace, or for enriching a poor quality of gas, in order to get the desired heat. This furnace can also be supplied in sizes varying from 15 by 15 inches to 15 by 36 inches.

SHUSTER STOCK STRAIGHTENER AND CUTTER

The machine shown herewith is designed to automatically straighten and cut to accurate lengths either square, hexagon or flat stock. It has a capacity for ¾ inch squares or hexagons and it will also handle flat stock 1¼ inch wide by ¼ inch thick. A maximum length of 20 feet can be cut, but only part of the extension of the machine is shown in the illustration.

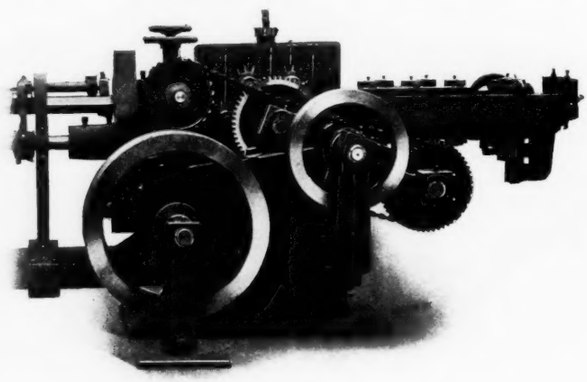


Fig. 1. Rear View of Shuster Stock Straightener

The machine is driven by a balance wheel (see Fig. 1), which connects with a train of gears operating the horizontal and vertical straightening rolls and feed rolls. There are five vertical and five horizontal rolls, all of which are gear driven. These rolls have grooves corresponding to the shape of the material they are to handle. The upper horizontal rolls and the rear vertical rolls are adjusted, by means of suitable screws, to suit the size of the material. The front feed rolls are adjusted by the handwheel shown above them, and they are driven in unison with the back feed rolls, by the chain and sprockets, seen in Fig. 1. The back feed rolls (at the left end of the machine) are also adjusted by a handwheel.

The extension consists of a guide-bar having a suitable groove for the shape of material being handled, and a cover or apron. There is an adjustable stop-gage which is set for the length to be cut. The coil of stock should be mounted on a suitable reel located at the end of the machine. The stock first passes through a guide and then enters the rear feed rolls. The straightening rolls are next encountered and then the front feed rolls. After passing the latter, the stock moves through a bush die, past the cutter knife and into the guide-bar until it strikes the stop gage previously referred to. Then

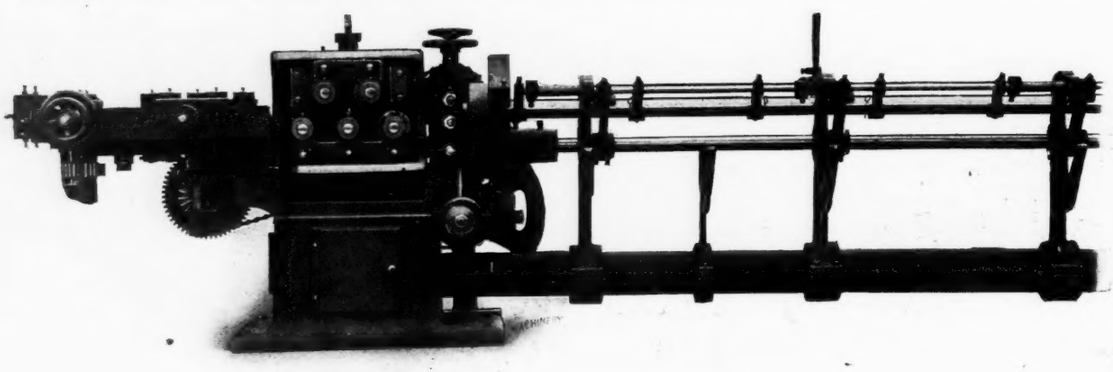
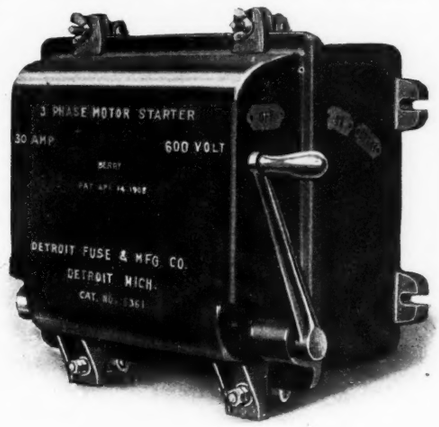


Fig. 2. Side View of Shuster Geared-roll Stock Straightener and Cutter

the cutting mechanism is automatically set in motion and the knife severs the piece, after which the guide-bar cover is thrown open and the cut rod drops out into the forked holders or brackets shown. As soon as the stock strikes the stop-gage, a clutch mechanism is thrown in, which releases the feed rolls and causes them to remain stationary while the cutting operation takes place. This machine is built by the F. B. Shuster Co., New Haven, Conn.

DETROIT THREE-PHASE MOTOR STARTER

A new type of three-phase motor starter is now being manufactured by the Detroit Fuse & Mfg. Co., 1400 Rivard St., Detroit, Mich. This starter makes it unnecessary to "fuse" a three-phase motor for the starting current, and it automatically protects the motor from injury, as well as the operator. The size shown in the illustration, has a capacity of 30 amperes at 400 to 600 volts, and it is especially adapted



Detroit Three-phase Motor Starter

for motor-driven machinery using alternating-current motors with any voltage above 250 and not exceeding 600.

The starter is of very substantial construction, and all the mechanical or moving parts are enclosed in a cast-iron box. The switch is operated by the hand lever seen at the side of the box. To start a three-phase motor, this lever is moved to the "start" position. This closes the circuit and places the fuses in the circuit, but "parallels" them with a solid copper bar which takes care of the starting load. It is necessary for the operator to hold the lever in the starting position until the motor reaches its normal speed; he then removes his hand from the lever and the parallel bars are thrown out of the circuit without opening it. This leaves the fuses completely protecting the motor at its running load, without at any time breaking the contact, as is done when a double-throw knife-switch is used for this purpose. There are no flimsy or complicated parts connected with this starter, and in its operation there is no possibility of accidental contact with "live" parts The three-phase starter is also made in a 200 to 250 volt size.

NEW MACHINERY AND TOOLS NOTES

Chuck Closer: Stark Tool Co., Waltham, Mass. Hand-operated chuck closer for bench lathes which enables the work to be released or clamped while the lathe is in motion. This chuck is operated by a lever at the left of the headstock.

Band Saw: Houghton & Richards, 26 N. Clinton St., Chicago, Ill. Tilting band saw designed for cutting metal. The saw is operated by gravity feed and the band wheels are mounted on a tilting arm which swings forward over the table and gives a continuous feeding movement.

Lathe Center: Stark Tool Co., Waltham, Mass. Self oiling lathe center which can be oiled without withdrawing it from the work. The hole through which the oil is inserted, is normally kept closed by an adjustable brass collar. This collar retains the lubricant and excludes dust or dirt.

Tapping Machine: Evans Stamping & Plating Co., Taunton, Mass. Vertical tapping machine having an automatic stop mechanism for tapping to any predetermined depth. This machine is built for either hand lever or foot lever operation. It has a capacity up to ¼ inch, and the work table is 11½ inches in diameter.

Drilling Machine: Richmond Stay-Bolt Drilling Machine Mfg. Co., 11 E. Broad St., Richmond, Va. Machine for drilling the tell-tale holes in boiler stay-bolts. The bolts are dropped into slots in a revolving carrier, and then all the operations are performed automatically. The carrier may be easily adjusted to accommodate bolts of different lengths.

Emery Wheel Guard: Challenge Machine Co., Inc., Philadelphia, Pa. Emery wheel protector and dust guard. The guard proper is made of four heavy steel bands which have great strength. At the ends of the guards in front, there are adjustable shields which deflect the grindings and protect the eyes of the workmen. The guard is attached to the machine by a heavy arm.

Pipe Threading Machine: The Loew Mfg. Co., Cleveland, Ohio. Pipe threading machine which will not only cut off and thread pipe, but also cut off and thread nipples without the use of a nipple chuck. This machine is a lathe bed type. The die-head is self-locking and self-releasing. There are two changes of speed obtained by shifting gears, and no countershaft is required, as tight and loose pulleys are provided on the machine itself.

Die-Sinking Machine: Newton Machine Tool Works, Inc., Philadelphia, Pa. Die-sinking machine designed to eliminate the use of special angular cutters by having a swiveling knee upon which the work table is mounted. By means of this angular adjustment of the work table, both internal and external clearances can be milled with straight cutters. The machine is equipped with both vertical and horizontal spindles and the latter is supported by an overhanging arm.

Speed Changing Mechanism: Burke Electric Co., Erie, Pa. Arrangement for changing the constant speed of alternating or direct-current motor, in connection with machine tool drives. It consists of a frame which supports a jack-shaft and the necessary pulleys for the speed adjustments. In the case of a lathe, the frame is attached to the headstock, and the jack-shaft is located above the main cone pulley, whereas the driving motor is mounted on an extension base at the rear.

Safety Device: J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y. Safety device for drop-hammers, designed to automatically prevent accidents to the operator when inserting work by hand. The device is used in connection with work which has to be "restruck" after the "flash" or excess metal has been removed. A spring steel guard is clamped to the guide or upright, and when the ram descends, the guard swings outward, thus forcing the hand of the operator away from the danger zone.

Gear Testing Machine: Peerless Gear Tester Mfg. Co., 602 Schofield Bldg., Cleveland, O. Gear tester for determining the concentricity, pitch diameter and variation in the tooth thickness of spur and bevel gears. The machine consists of a horizontal base, having a stationary and a movable block carrying hardened and ground studs for holding the master gear and the gear to be tested. There is also the necessary mechanism for transmitting the motion caused by inaccuracy in the gear being tested to pointers swinging over graduated dials.

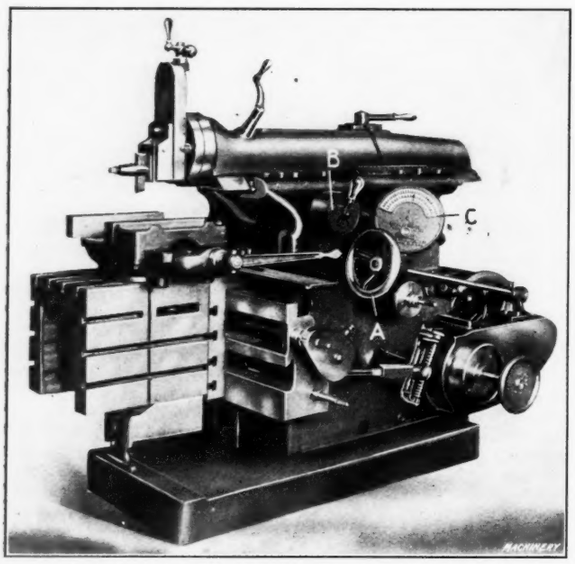
Surface Grinder: Northampton Emery Wheel Co., Leeds, Mass. Grinder for surfacing dies, chucks, straightedges, surface-plates, typewriter parts and all similar work within the capacity of the machine. This grinder is of the column-and-knee type and the table can be operated either by hand or automatically. The vertical feed is shown by a dial graduated in thousandths of an inch. Three sizes are built, the smallest of which has a table measuring 10 by 24 inches and the largest, 10 by 36 inches. A 12-inch wheel is used, and the side feed can be varied from 1/64 to 1/8 inch per stroke.

Motor Drive for Lathes: South Bend Machine Tool Co., South Bend, Ind. Double-belt reversible motor drive for lathes, consisting of a cast-iron bracket pivoted to a casting attached to the rear of the bed and carrying both the countershaft and motor. The motor is mounted on the lower end of this bracket and is connected to the countershaft at the upper end by open and cross belts. A cone pulley on the countershaft is belted to the headstock pulley, and the proper tension for this driving belt is obtained by simply adjusting the rear bracket by means of a screw in front of the lathe. The forward and reverse movements are controlled by a horizontal shifter rod which extends along the lathe bed and is within convenient reach.

The Periodograph: Gisholt Machine Co., Madison, Wis. Recorder for keeping accurate record of time required by workmen on various jobs. Each man is supplied with a card on which the recorder registers the time at which a piece of work is started. When the job is completed, the card is again placed in the recorder and the finishing time is automatically registered just above the starting time. By simply subtracting the lower figure from the upper, the net time is obtained. Spaces are provided on the card for several starts and stops, and by carrying the net periods to the right, it is easy to sum up the total time. The stamp automatically locates the card, so that the recorder can be operated by the workmen without chance of error.

SHAPER HAVING AUTOMATIC STARTING CONTROL AND SPEED DIAL

A motor-driven crank-shaper equipped with an automatic starting control and a speed dial for obtaining any desired cutting speed, is illustrated herewith. This is a Gould & Eberhardt machine and it is driven by a 5 horsepower Reliance adjustable-speed motor having a speed range of from 300 to 1500 revolutions per minute. The speed adjustments are obtained by mechanically shifting the motor armature by handwheel *A*. When the speed is properly set for a given operation, the motor can be stopped and started as often as desired, without further attention to the speed adjustment. This is due to the fact that the starting and stopping is entirely separate from the speed regulation and is controlled by an automatic



Motor-driven Crank Shaper equipped with Automatic Starting Control and Speed Dial

starter through the drum switch *B*. This switch has three positions, namely, the "start," "off," and "brake" positions. To start the motor, it is simply necessary to throw the switch to the starting position. When the switch is moved to the "off" position, the power is shut off, and the time then required for the machine to stop will depend upon the time required for friction to overcome the momentum of the moving parts. When the switch is thrown to the "brake" position, the motor is automatically brought to a stop almost instantly. This simple method of stopping eliminates the necessity of a clutch, and the motor is never running idle, thus unnecessarily wasting power. The starter, which is mounted on a nearby post, is of the series control type and automatically takes care of all starting conditions. All wires are carried in a conduit which is tapped directly in the drum switch, so that there is no exposed wiring.

The speed dial *C* is a device used with the Reliance adjustable-speed motors to enable the motor speed to be quickly regulated for obtaining any required cutting speed of the tool. This device is in the nature of a circular slide rule, and, in the case of a shaper, it takes into account all the variable factors, such as the ratio of the drive and the length of the stroke. The method of using this dial was described in the March number of MACHINERY. It is the product of the Reliance Electric & Engineering Co., Cleveland, Ohio.

* * *

PERSONALS

Henry L. Gantt spoke on "Scientific Management" before the American Society of Swedish Engineers, Brooklyn, N. Y., Saturday evening, March 23.

William H. Holland, of the Sibley Machine Tool Co., South Bend, Ind., has succeeded Mr. Walter A. Sibley as president and general manager.

E. H. Pratt, Lansing, Mich., has been promoted from the position of toolroom foreman to that of tool engineer of the Olds Motor Works of Lansing.

Frank P. Judge, formerly head of the mechanical department of the Wells Bros. Co., Greenfield, Mass., has been appointed general superintendent of the company's bolt cutter and gage shops.

George V. Rottweiler has resigned as chief engineer and factory manager of the Falls Machine Co., Sheboygan Falls, Wis. Mr. Rottweiler designed the line of gasoline motors built by the motor department of the company.

E. E. Barney of Syracuse, N. Y., the present manager of the Smith Premier Typewriter Works of Syracuse, has been appointed manager of the Remington Typewriter Works of Ilion, N. Y., to succeed Mr. John Calder, whose resignation takes effect May 15.

Albert G. Lea, who for the past five years was president of the Lea Equipment Co., New York and Philadelphia, has disposed of his interest in the company to Philadelphia parties, and has resigned as president. Mr. Lea will not enter active business for the present.

John Calder, who for several years has been manager of the Remington Typewriter Works, Ilion, N. Y., has resigned his position, effective May 15, to take a position with the Cadillac Motor Car Co., Detroit, Mich., where he will be associated with the management.

D. De Vries, manager of the well-known firm of dealers, R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland, is in this country, where he arrived February 20. Mr. De Vries expects to remain for about eight weeks, visiting the principal machine tool concerns throughout the country.

George Langen, works manager of the Cincinnati Planer Co., Cincinnati, Ohio, sailed March 18 for Europe, where he will make a trip covering the entire continent. Mr. Langen expects to be gone four or five months. The trip is taken principally in the interests of his company.

Walter B. Snow, publicity engineer, 170 Summer St., Boston, has increased his organization by the addition of Mr. Charles L. Mulligan, late of the editorial staff of the Brooklyn *Standard-Union*, and for a considerable period associated with the publicity department of the Western Electric Co.

Howard D. Penney, for several years foreman for the Knox Automobile Co., Springfield, Mass., and for the past two years with the Parker Transmission & Appliance Co., of the same city, has taken a foreman's position with the Hendee Mfg. Co., manufacturers of the Indian motorcycle, of Springfield.

C. F. Barker of the firm of Gilbert & Barker Mfg. Co., Hartford, Conn., retired from the firm on January 1, 1912, having reached the age where he felt that he had earned a well-deserved rest. Shortly before retiring, his associates in the office presented him with a clock as a token of their esteem and good wishes.

Frank D. Chase, associate member of the American Society of Civil Engineers and architect of the Western Electric Co., has opened offices in the Peoples Gas Bldg., Chicago, Ill., for the practice of architecture and industrial engineering. Mr. Chase will make a specialty of manufacturing plants and mercantile buildings.

Allen D. Risteen, who for the past twenty-three years has been assistant editor and editor of *The Locomotive*, Hartford, Conn., has resigned to become connected with the Travelers' Insurance Co., of the same city. Dr. Risteen has contributed many valuable articles on steam boiler inspection and practice to the technical press.

Arthur B. Tilton, assistant advertising manager of Hoskins Mfg. Co., Detroit, Mich., has been made advertising manager, succeeding Mr. H. Ralph Badger, resigned. Mr. Badger, who had been with the Hoskins Mfg. Co. for three years as publicity manager and assistant manager of sales, will for the present confine his attention to personal interests.

H. E. Harris has been appointed general superintendent of the Wells Bros. Co.'s tap and die plant. He was formerly the company's assistant superintendent and production engineer and came to them from the Western Electric Co., with which he had been master mechanic and methods engineer. Mr. Harris read the paper "Taps and Tapping," presented before the monthly meeting of the A. S. M. E., March 12.

George J. Henry, Jr., who has had eighteen years' experience with the Pelton Water Wheel Co., San Francisco and New York, ten years of which were spent as the company's chief engineer, and the past six years as chief engineer and sales manager, has resigned, and opened an engineering office at No. 737 Rialto Building, San Francisco, Cal. Mr. Henry will specialize on hydraulic machinery and hydraulic installations.

George H. Graves, treasurer, and George T. Coppins, secretary, of the Walworth Mfg. Co., Boston, Mass., were recently presented with loving cups by twenty employes of the company, only two of whom have been in the company's service less than twenty years. The average term of service of the givers of the cups is thirty-one years. Mr. Graves has been with the company forty-seven years, and Mr. Coppins thirty years.

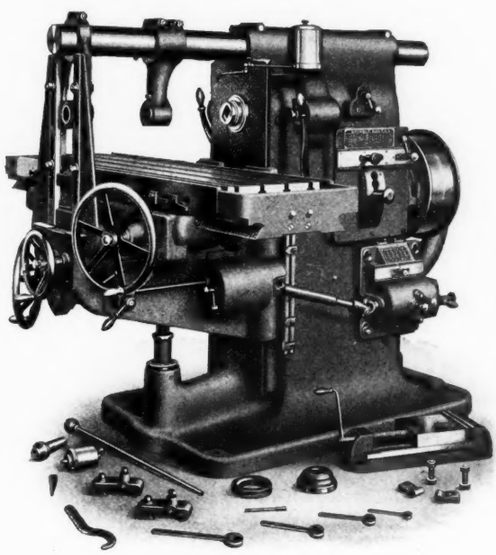
H. R. Setz, who has been chief engineer of the Struthers Wells Co., Warren, Pa., for the past two years, has taken the

Heavy Plain Milling Machines Offer Many Opportunities to Reduce Production Costs

Many heavy jobs in our shops that were formerly done on the planer are now put on a Heavy Plain Milling Machine.

A saving of at least one-half and sometimes considerably more of the time formerly required is effected in this way.

Consequently, the cost of work is likewise lowered.



No. 5B HEAVY PLAIN MILLING MACHINE

Such savings in time and cost are surely worthy of consideration.

Perhaps there are many jobs in your shop that can be done to distinct advantage on a heavy plain milling machine, and a study of the few points following may serve to open the way to a material saving in manufacturing costs.

All B. & S. Heavy Plain Milling Machines are exceptional examples of strong, rigid construction and are fully capable of taking continuous heavy cuts.

They are easily adjusted to accommodate different pieces of work, and are handy to operate.

The No. 5 B Heavy Plain Milling Machine shown is the largest size. Its table has both power and hand feeds—longitudinally, 50″, transversely, 12″, and vertically, 21″. The driving pulley is 20″ in diameter, takes 7″ belt, and runs at 320 R. P. M. Net weight 10,750 lbs.

This machine is designed particularly for the heavier work in machine tool, engine and railroad shops.

The constant speed type of drive embodied in these machines enables the full power delivered to be available at the spindle under all conditions of spindle speed.

It also permits of the speeds and feeds being independent of one another.

A friction clutch, operated by handles at each side of the machine, obviates the necessity of shifting a heavy belt to stop the machine.

Special circulars describe these and many other features more fully, and we shall be glad to send you copies free.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

position of chief engineer with the Otto Gas Engine Works of Philadelphia. Mr. Setz was formerly connected with several of the leading European and American gas and oil engine manufacturers. His attention will be chiefly directed toward the development of a complete line of Otto-Diesel engines of the horizontal type.

C. C. Owens was recently placed in charge of the Detroit sales office of the Westinghouse Electric & Mfg. Co., with the title of district manager. Mr. Owens was born in 1877 and graduated from Columbian University, Washington, D. C. He entered the employ of the Westinghouse Electric & Mfg. Co. in 1896, taking the apprenticeship course for three years in the engineering department, specializing on switchboards and controllers. For the past eight years he has been connected with the New York sales office.

William R. Wherry, a Pennsylvania R. R. passenger conductor, was retired March 22, at the age of sixty-seven, after fifty years of active service. In this period he was never suspended or disciplined in any manner. Mr. Wherry was born in Cambria County, Pa., and when seventeen years old was employed by the Pennsylvania R. R. Co. as a freight brakeman. One promotion followed another until he was made a passenger conductor on the Pittsburg Division, where he is employed at the present time. The record of this passenger conductor, who is the type of man the company puts in charge of its trains, is given in a letter written by him to his superintendent: "I have now been running a passenger train for almost forty-six years and in that time have never had a serious accident, never had a passenger seriously injured or killed, have never been fined or suspended, always got along well with the traveling public, was never reported by a passenger that I heard of, and never was the cause of any lawsuits, which, when you consider the number of people of all kinds I have handled, is a wonder. It has always been my aim to do everything in my power to take my train over the division safely, and I have always held the company's interests first and have been loyal to it. I have never been seriously injured, but have had some very narrow escapes, having fallen between freight cars, and been knocked down by an engine and squeezed between cars."

* * *

OBITUARIES

Henry W. Spangler, Whitney professor of dynamical engineering, University of Pennsylvania, Pa., died March 17.

Alanson H. Merriman, a manufacturer of drop presses for the past forty years, died in Hartford, Conn., March 4, aged eighty-four years.

Frank E. Eggleton, superintendent of the molding department of the Waterbury Farrel Foundry & Machine Co., died March 5, at his home in Waterbury, of pneumonia, aged forty-six years.

John H. O'Donnell, regarded as an authority on wire drawing machinery, died at his home in Waterbury, Conn., February 27, aged forty-eight years. He was the inventor of the diamond wire-drawing die, and was prominently identified with various concerns in Waterbury and Seymour, Conn., and Worcester, Mass.

Charles Hart, president of the Hart Mfg. Co., Cleveland, Ohio, died February 9, aged sixty-two years. He was a lifelong resident of Cleveland and established the company of which he was president and treasurer, thirty years ago. He is survived by a widow, daughter and son, Mr. Louis F. Hart, vice-president and secretary of the company.

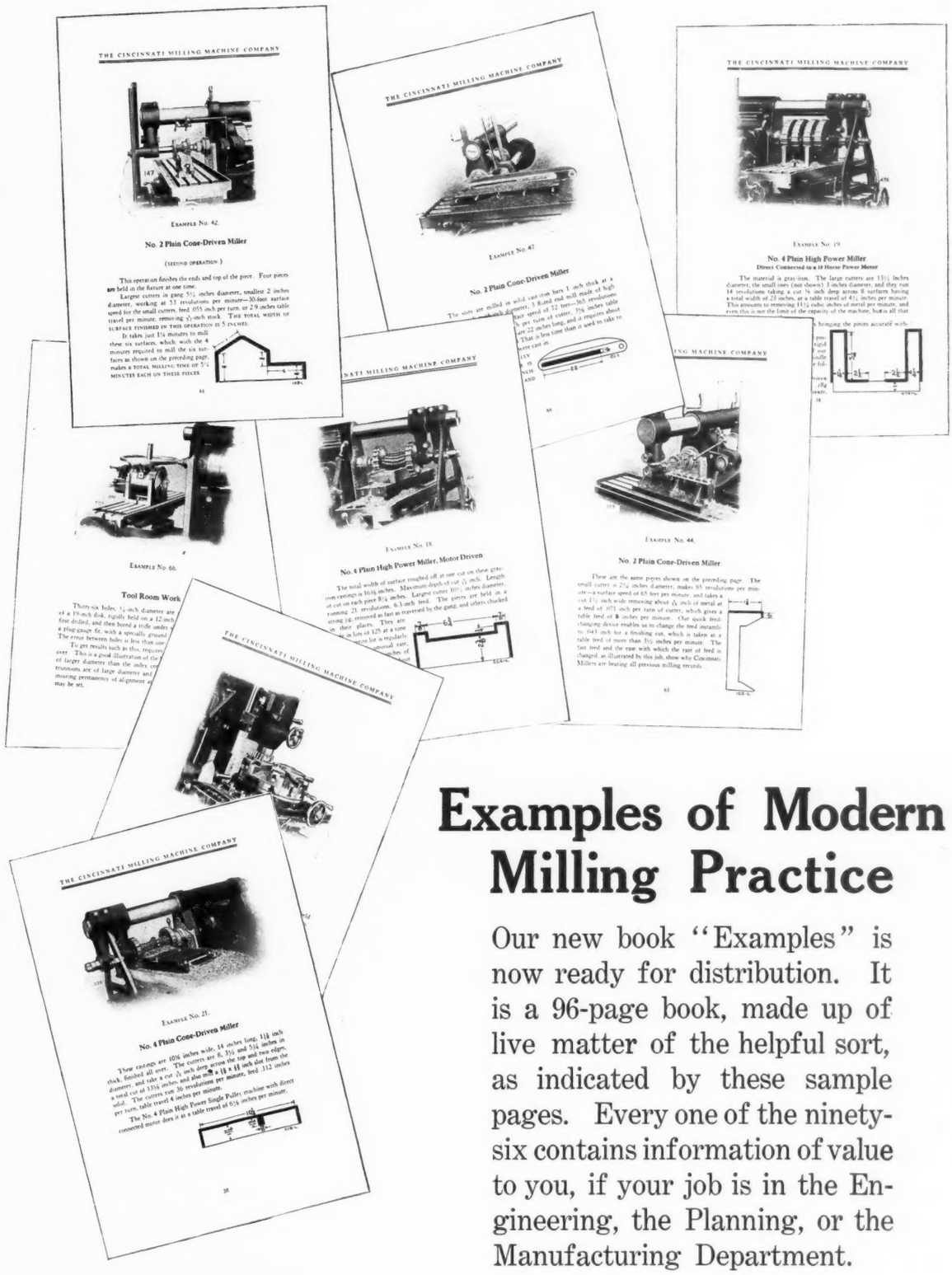
Elias G. Heller, president of the Heller Bros. Co., Newark, N. J., prominent steel and file makers, died at his home in the Forest Hill section of that city, March 22, of pneumonia, following apoplexy, in his seventy-fifth year. The firm of Heller Bros. was established in 1865 by the three brothers, Elias, Peter and Lewis, and a factory was built in the following year. The business soon outgrew the capacity of the building and a much larger plant was built in 1872. Lewis Heller withdrew from the firm in 1870 and Peter Heller in 1880, in which year the brothers George and John Heller were made members of the firm. Mr. Heller is survived by a widow and three sons, Paul E., Arnaud G., and R. Arthur Heller.

Rear-Admiral George W. Melville, formerly engineer-in-chief of the U. S. Navy, and world-famous as an engineer, inventor scientist and Arctic explorer, died at his home in Philadelphia, March 17 of paralysis, aged seventy-one years. At the outbreak of the Civil War, Melville, then twenty years old, entered the U. S. Navy and became an officer of the engineer corps. He saw much active service during the war and at its close was attached to the *Tacony*, with which vessel he served in the Gulf of Mexico during the occupation and evacuation of Mexico by the French. Melville's career as an Arctic explorer began with a trip to the North in 1873, when as assistant officer of the small sealing steamer *Tigress* he assisted in the search for the remaining members of the crew of the *Polaris*. Later he was the engineer officer of the ill-fated *Jeannette* expedition, and returned from this terrible experience in 1882. In the spring of 1884 he again went into the frozen North with the squadron dispatched to the relief of the Greeley expedition, the survivors of which were rescued in 1884. He was appointed engineer-in-chief of the Navy in 1887 for a term of four years and was reappointed four times successively, his retirement taking place in 1903. During this long period in the naval service one-hundred-and-twenty vessels were constructed, aggregating 700,000 horsepower. Rear-Admiral Melville was elected vice-president of the American Society of Mechanical Engineers 1895-97, president of the society in 1899, and in 1910 he was made an honorary member. Some years after his retirement from the Navy he and John Macalpine were associated in Philadelphia as a firm of consulting engineers and naval architects. During this association the Melville-Macalpine reducing gear was successfully developed for coupling steam turbines to marine propellers for the efficient propulsion of ships.

Milton Prince Higgins

MILTON PRINCE HIGGINS

Milton Prince Higgins, president of the Norton Co., and Norton Grinding Co., died Friday, March 8, at his home in Worcester, Mass., aged sixty-nine years. Mr. Higgins was born December 7, 1842 in Standish, Maine. He was the descendent of an old Cape Cod family which originally came from England in 1633. At the age of seventeen years he left home to serve an apprenticeship in the shops of the Amoskeag Mfg. Co., Manchester, N. H. While serving his time he studied evenings and saved enough money to enable him to go through Dartmouth College, from which he graduated in 1868. After his graduation he entered the employ of the Washburn & Moen Mfg. Co., under the late Mr. Charles Hill Morgan and later took a position as superintendent of the Washburn Shops of the then newly organized Worcester Polytechnic Institute, where he remained for twenty-eight years. In 1903 he was appointed a trustee of the Institute, which position he held until his death. Mr. Higgins took an active interest in the establishment of trade schools for mechanics, and his influence in industrial education has been wide-spread. During his association with the Worcester Polytechnic Institute he obtained a year's leave of absence to organize the shops of the Georgia School of Technology at Alabama. He also planned the shops of the Miller Manual Labor School of Virginia. In 1899, he presented a paper before the American Society of Mechanical Engineers on the education of machinists, foremen and mechanical engineers, thus being the first to introduce to the public the "half-time" school proposition. He was appointed a member of the state board of education by Governor Douglas of Massachusetts, and his vigorous efforts in this connection led to the establishment of the Worcester Trade School in 1908. While at the Washburn Shops, Mr. Higgins became interested in a small emery wheel business which he acquired in company with Prof. Alden. Under their management this business grew into the well-known firm of the Norton Emery Wheel Co., which later became the Norton Grinding Co. In 1896, the Worcester Polytechnic Institute sold its hydraulic elevator business to Mr. Higgins and Prof. Alden, who had been instrumental in building it up. Thus the Plunger Elevator Co. was established and carried on successfully until its absorption a few years ago by the Otis Elevator Co. In 1904, Mr. Higgins acquired an interest in the Worcester Ferrule & Mfg. Co., which in a few years greatly increased its business and was reorganized as the Worcester Pressed Steel Co. He was also president of the Manchester Supply Co., Manchester, N. H., and of the Sanford Riley Stoker Co., Providence, R. I. Mr. Higgins was a member and past vice-president of the American Society of Me-


THE CINCINNATI MILLING MACHINE COMPANY
EXAMPLE No. 42.
No. 2 Plain Cone-Driven Miller
(SECOND OPERATION)
EXAMPLE No. 47.
No. 2 Plain Cone-Driven Miller
EXAMPLE No. 19.
No. 4 Plain High Power Miller
Direct Connected to a 10 Horse Power Motor
EXAMPLE No. 66.
Tool Room Work
EXAMPLE No. 18.
No. 4 Plain High Power Miller, Motor Driven
EXAMPLE No. 44.
No. 2 Plain Cone-Driven Miller
EXAMPLE No. 21.
No. 4 Plain Cone-Driven Miller

Examples of Modern Milling Practice

Our new book "Examples" is now ready for distribution. It is a 96-page book, made up of live matter of the helpful sort, as indicated by these sample pages. Every one of the ninety-six contains information of value to you, if your job is in the Engineering, the Planning, or the Manufacturing Department.

We will send it anywhere, postage free, on request.

The Cincinnati Milling Machine Company

Milling Specialists **Cincinnati, Ohio, U. S. A.**

chanical Engineers and a charter member of the Society for the Promotion of Engineering Education. He leaves a widow, two sons and two daughters. One of his sons, Alden C. Higgins, is with the Norton Co., and the other, John W. Higgins, is manager of the Worcester Pressed Steel Co.

* * *

COMING EVENTS

April 10-11.—Fourteenth annual convention of the National Metal Trades Association in New York, Hotel Astor headquarters. Robert Wuest, commissioner, New England Bldg., Cleveland.

May 13-15.—Triple convention of the American Supply and Machinery Manufacturers' Association, National Supply and Machinery Dealers' Association, and Southern Supply and Machinery Dealers' Association, at Norfolk, Va., Monticello Hotel, headquarters. F. D. Mitchell, secretary-treasurer, 309 Broadway, New York.

May 13-25.—Newark industrial exposition under the auspices of the Board of Trade of Newark, N. J., in the First Regiment Armory. It is claimed that one hundred thousand different articles are manufactured in the three thousand shops of the Newark industrial district, the diversity being proportionately greater than that of any other manufacturing district in the country. William G. Rose, manager, Newark, N. J.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Building, Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

May 16-17.—Semi-annual convention of the National Machine Tool Builders' Association at Atlantic City, N. J., Hotel Chalfonte headquarters. E. P. Bullard, Jr., president, Bridgeport, Conn.; James H. Herron, secretary, Cleveland, Ohio.

May 20-22.—Railway Storekeepers Association's convention in Buffalo, N. Y. Hotel Statler, headquarters. Wm. E. Kelley, secretary-treasurer, 825 Wabash Ave., Chicago, Ill.

May 28-31.—Spring meeting of the American Society of Mechanical Engineers in Cleveland, Ohio. Hotel Hollenden, headquarters. Calvin W. Rice, secretary, 29 W. 39th St., New York.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

July 9.—Annual convention of the American Railway Tool Foremen's Association in Chicago. H. L. Miller, secretary of the supply association, 835 Monadnock Bldg., Chicago, Ill.

August 20.—Annual convention of the International Railroad Master Blacksmith's Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. H. F. J. Porter, secretary, 1 Madison Ave., New York.

September 24-26.—Annual convention of the American Foundrymen's Association and allied bodies, in Buffalo, N. Y.; Hotel Statler, headquarters. Richard Moldenke, Watchung, N. J., secretary.

October 7-11.—Annual convention of the American Electric Railway Association and allied associations in Chicago, Ill. The exhibit will be at Dexter Pavilion, 43d and Halstead Sts. H. C. Donecker, secretary-treasurer, 29 W. 39th St., New York.

SOCIETIES, SCHOOLS AND COLLEGES

MANUFACTURERS' ASSOCIATION OF HARTFORD COUNTY, Hartford, Conn. Circular on a cooperative continuation course for shop boys offered by the Hartford Public Schools, which has been provided to fill the need of more efficient training for shop men, long felt by the manufacturers of Hartford. Charles B. Cook, manager of the Royal Typewriter Co., is chairman of the industrial educational committee of the Association.

FRANKLIN INSTITUTE, acting through its Committee on Science and the Arts, recently awarded the Elliott Cresson gold medal, the highest in the gift of the Institute, to the following gentlemen: Alexander Graham Bell, of Washington, D. C.; Samuel Wesley Stratton, of Washington, D. C.; Albert A. Michelson, of Chicago, Ill.; Alfred Noble of New York City; Elihu Thomson, of Swampscott Mass.; Edward Williams Morley, of West Hartford, Conn.; Johann Friedrich Adolph von Baeyer, of Munich, Germany; Sir William Crookes of London, England, and Sir Henry Enfield Roscoe, of London, England.

OSCAR E. PERRIGO, 6 Beacon St., Boston, Mass., has made an advance in the methods of correspondence school work whereby the courses of instruction are reduced in average cost and made of greater practical value to students. A special course is arranged for each individual to fit individual needs, and the tuition rates are made proportional to the requirements of the individual. The student is not required to spend time necessary to go over matter already well known, and he pays only for those parts of the course in which he needs specific instruction. The advantages of the system are obvious. Theory, practice and system for clerks, mechanics, engineers, accountants, manufacturers and other men connected with industrial work are taught.

NEW BOOKS AND PAMPHLETS

MECHANICAL STRESSES IN TRANSMISSION LINES. By A. GUELL. 31 pages, 6 by 9 inches. 10 illustrations. Price, 20 cents. 5 tables. Published by the University of Illinois, Urbana, Ill.

INDUCTANCE OF COILS. By Morgan Brooks and H. M. Turner. 72 pages, 6 by 9 inches. 25 illustrations and charts and 12 tables. Price, 40 cents. Published by the University of Illinois. Urbana, Ill.

BULLETIN OF SYRACUSE UNIVERSITY. Syracuse, N. Y. 509 pages, 5½ by 8½ inches. Contains general information on admission, courses, examinations, and list of students. Published by the University, Syracuse, N. Y.

ANNUAL REPORT OF THE DIRECTORS OF AMERICAN TELEPHONE AND TELEGRAPH CO. to the Stockholders, for the year ending December 31, 1911. 51 pages, 6 by 9 inches. Published by the American Telephone & Telegraph Co., New York.

FIFTY YEARS OF THE ARKWRIGHT MUTUAL FIRE INSURANCE COMPANY. By Edward V. French. 123 pages, 6 by 9 inches. Numerous illustrations, maps and charts. Published by the Arkwright Mutual Fire Insurance Co., Boston, Mass.

This book contains a history of the development of, and work done by the Factory Mutual Fire Insurance Companies during the past seventy-five years, and deals especially with that part of the work done by the Arkwright company in inducing manufacturers to cooperate for the prevention of fires in their plants, and for obtaining insurance at cost. The book is distributed to engineers, architects, manufacturers and others connected with and interested in fire prevention engineering. It gives a great deal of technical information, and should be very valuable to any one on whom it devolves to take precautionary measures against fire.

PRACTICAL PROBLEMS FOR VEHICLE DRAFTSMEN AND MECHANICS. By R. B. Birge and Hugh M. Sargent. 80 pages, 12 by 9 inches. Published by Ware Bros. Co., Philadelphia, Pa. Price $2.00.

This work is the outgrowth of practical experience in the classroom. The authors state that while intimately connected with the vehicle industry, they, in 1909, conducted an evening class in carriage drafting, and that the results of the first year were so encouraging that the work was continued through another year; the many problems which came up for discussion and solution in relation to the highly technical work of carriage body drafting were collected, and have formed the basis of the present treatise. The work contains first a number of geometrical definitions, followed by specific problems of particular interest to the carriage-maker. It is profusely illustrated, and contains not less than thirty-one full page plates with problems, and drawings of carriage bodies. The typographical execution of the book and the paper on which it is printed are of the best, making the intricate drawings extremely sharp and clear, and leaving nothing to be desired as regards distinctness in the execution of the design.

ENGINEERING AS A VOCATION. By Ernest McCullough. 201 pages, 5½ by 8 inches. Published by David Williams Co., New York. Price $1.00.

The subject matter of this work has been re-arranged from a number of addresses presented before technical schools, and is especially published for the information of parents in order that they may form a correct judgment in advising a career for their sons. In his preface the author states—certainly with considerable truth—that semi-technical periodicals and daily newspapers are the bureaus of information frequently consulted in matters of this kind, and perhaps more than one-half the students now in the technical schools are there because of the advice obtained from such sources. The book deals with the work of the engineer, the education of the engineer, and home study course. One chapter is entitled "How to Hunt and Hold a Job," and another, "Does it Pay to Study Engineering?" The work contains exact information on many subjects on which the prospective engineer should be informed, and will undoubtedly prove of value to anyone who is planning an engineering education for himself or for others.

WOOD-WORKING SAFEGUARDS. By David van Schaack. 217 pages, 6¾ by 9¾ inches. 320 illustrations. Published by Aetna Life Insurance Co., Hartford, Conn. Price $1.00.

This book offers a great number of practical suggestions for safeguarding workmen engaged in the lumbering and wood-working industries. It confines itself chiefly to machines, operations and conditions which are more or less common, but the suggestions contained should impress manufacturers with the possibilities in safeguarding, which, with some variation, will be applicable to many of the special machines used which it has not been possible to touch upon in a work of limited extent. The book is profusely illustrated, so as to clearly show the suggested safeguards. Different sections of the book are devoted to logging, saw mills, planing mills, circular saws, band saws, jointers, shapers, sanders, etc., and to the various wood-working industries. Special attention is also given to power generation and transmission, grinding wheels, and elevators. A carefully compiled index is an important feature of the book. It deserves a place on the desk of the executive of any industrial establishment employing wood-working machinery.

MARINE STEAM TURBINES. By G. Bauer and O. Lasche, assisted by E. Ludwig and H. Vogel. Translated from the German and edited by M. G. S. Swallow. 214 pages, 6 by 9 inches. 103 illustrations. 18 tables. Published by Norman W. Henley & Son, New York. Price $3.50.

The use of steam turbines for the propulsion of naval vessels has increased to a considerable extent during the last few years. The present book will therefore be welcomed by many engineers who are especially interested in this subject. The book is the work of men engaged in practical pursuits, and while it contains the necessary theory, yet the theoretical discussions have been presented in such a way as to be useful to any engineer with enough fundamental training to enter successfully upon the subject of the theory of steam turbines. The book is divided into ten parts headed as follows: Introduction; General Remarks on the Design of a Turbine Installation; The Calculation of Steam Turbines; The Turbine Design; Shafting and Propellers; Condensing Plant; Arrangement of Turbines; General Remarks on the Arrangement of Steam Turbines in Steamers; Turbine-driven Auxiliaries; and Tables. Being partly the work of an author who has already made himself favorably known to the steam engineering profession by his "Marine Engines and Boilers," it is safe to predict that the present book will be well received by engineers.

APPLIED METHODS OF SCIENTIFIC MANAGEMENT. By Frederic A. Parkhurst. 325 pages, 6 by 9 inches. 48 illustrations and 9 folding plates. Published by John Wiley & Sons, New York. Price, $2.00.

This book is based on a series of articles published by the author in *Industrial Engineering*, during 1911. A considerable amount of new matter, not contained in the original articles, is, however, included. The book does not deal with mere principles, but shows the actual application of these principles to every-day practice. As a concrete example, the history of the application of scientific management to the works of the Ferracute Machine Co., at Bridgeton, N. J., is recorded. The system adopted, closely follows the lines laid down by Fred W. Taylor, and is particularly suited to businesses employing one hundred people or more. The book is logically arranged, and commends itself particularly to the manager or superintendent on account of the practical, precise and detailed manner in which it has been written. The "glittering generalities" with which books and articles on scientific management have often been filled, are here reduced to distinct rules and descriptions of definite methods. The appendix, which contains most of the new matter not included in the original publication, and which covers over one hundred pages of the book, is especially profuse in definite information relating to the duties of the various officers and men in the shop, with instructions for each. The thoroughness of the treatment in this respect may be judged from the fact that instructions are included for the duties of the shop drawing boy, the night watchman, the janitor, the crane boss, etc. Altogether, it seems that this is the very kind of a book which persons who have looked for really practical and definite information on scientific management, will welcome.

NEW CATALOGUES AND CIRCULARS

GENERAL ELECTRIC CO., Schenectady, N. Y. Booklet No. 4930 on electrically driven refrigerating machinery.

GISHOLT MACHINE CO., Madison, Wis. Leaf illustrating Gisholt 36-inch boring mill equipment for finishing flywheels in one chucking.

MAX AMS MACHINE CO., Mt. Vernon, N. Y. Circular of the Ams power presses, showing a few of the recent designs and additions to the line.

CHALLENGE MACHINE CO., INC., Philadelphia, Pa. Circular of the Challenge emery wheel protector and dust guard for the protection of workmen.

BLOOD BROS. MACHINE CO., Kalamazoo, Mich. Circular of universal

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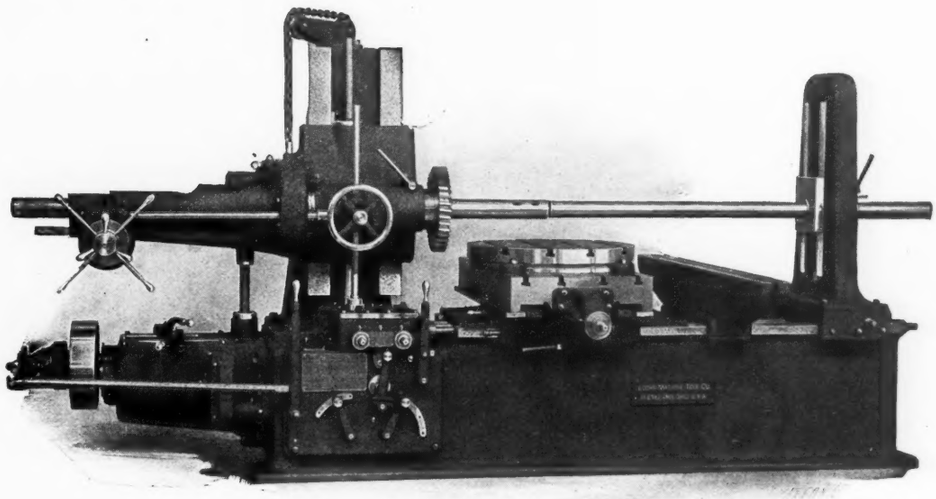
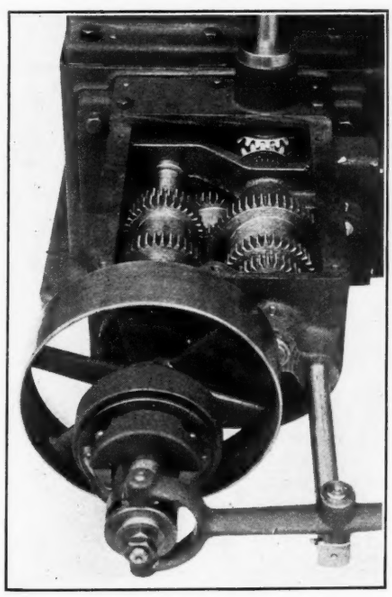
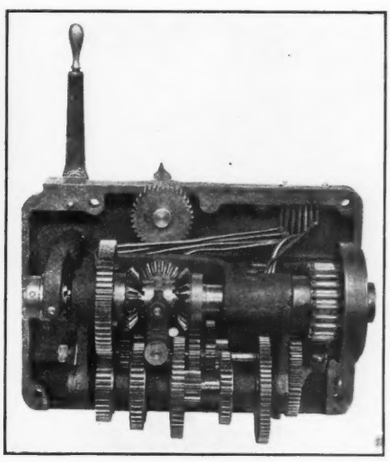
BORING, DRILLING AND MILLING MACHINE





THE SPEED BOX



THE FEED BOX

These boxes are shown approximately under the positions they occupy on the machine. Note that they are UNITS, each complete in itself, and involved in no way with each other, hence, **SIMPLICITY.**

Note also the **large size** of the boxes by comparing them with the bed, as shown in position on the machine, giving room for gears of **large diameter,** hence, **STRENGTH.**

These are two good things about the "PRECISION"—everything else about it has had the same careful attention in designing. The ACCURACY alone of the "PRECISION" would make it, as it is, the favorite of those who require something **RELIABLE.**

Lucas Machine Tool Co., NOW AND ALWAYS OF **Cleveland, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co , London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Can.

joints which are made in over one-hundred patterns, encased and open, single and double forms.

FORT WAYNE ELECTRIC WORKS OF THE GENERAL ELECTRIC Co., 1616 Broadway, Fort Wayne. Ind. Catalogue of electric fans; and bulletin No. 1134 on direct-current electric motors.

S. A. WOODS MACHINE Co., Boston, Mass. Booklet on inside wood molders, illustrating Nos. 107 and 107-B machines and details; also a universal side-head grinder and automatic knife grinder.

BROWN HOISTING MACHINERY Co., Cleveland, Ohio. Circular on "Brownhoist" rapid freight handling equipment, showing freight handling trolleys, roller bearing freight trucks, lumber trolleys, etc.

GILBERT & BARKER MFG. Co., Springfield, Mass. Catalogue A on oil storage systems for factory store-rooms, paint stores, hardware and commissary stores and mines, designed for handling heavy lubricating and non-lubricating "gummy" oils.

HOLUB-DUSHA Co., 93d St., and First Ave., New York. Catalogue of button machinery, comprising cutting lathes, blank splitters, thickness gages, emery stands, backing machines, button grinding machines, facing and turning lathes, drilling machines, etc.

GARWOOD ELECTRIC Co., Garwood, N. J. Leaflet illustrating a 5-horsepower "C & C" motor which has been running twenty-two years, driving the presses of the Hartfield Telegraphic Code Publishing Co. The motor is still in good condition and is in daily use.

CLING-SURFACE Co., 1018 Niagara St., Buffalo, N. Y. has issued Bulletin No. 321, a neat folder showing eleven noteworthy installations in Pennsylvania where "Cling-Surface" is profitably used on belts. Each illustration is accompanied by data concerning the belts shown.

GENERAL ELECTRIC Co., Schenectady, N. Y. Booklet No. 4927 on feeder voltage regulators, illustrating the various processes of manufacture and showing the facilities possessed by the company at its Pittsfield works for the manufacture of this type of apparatus.

SKF BALL BEARING Co., 50 Church St., New York. Bulletin No. 2 on SKF single- and double-thrust ball bearings, illustrating the self-aligning feature provided for both types; also single-thrust bearings, without self-aligning seats, capacities and sizes of all forms are listed.

E. G. SMITH Co., Columbia, Pa. Catalogue of "Columbia" beam calipers graduated in inches and metric measure, with and without verniers. The catalogue also lists and illustrates "Which Way" pocket levels, the "Columbia" spherometers, spring gages and other machinists' tools.

SUPERIOR MACHINE TOOL Co., Kokomo, Ind. Leaflet on sensitive vertical drilling machine equipped with high-duty roller bearing bushings, and having the features of constant drive, constant power factor, geared speed change box, unit spindle construction, and front control of all speeds.

FAIRBANKS Co., 416-422 Broome St., New York. Circular of the Osgood oil-groove cutting machine which cuts continuous spiral grooves in interior bushings or on the exterior of shafts, journals or studs. The capacity of the machine is from ⅜ inch to 7¾ inches in diameter and from 1½ inch to 20 inches long.

FALLS MACHINE Co., Sheboygan Falls, Wis. Catalogue of Falls gasoline motors of the tandem four-cylinder automobile type in three models of 40–45, 30–35 and 30–40 horsepower, respectively. The company also furnishes unit power plants in two models with or without foot pedals, control levers and transmission brake.

VEEDER MFG. Co., 39 Sargeant St., Hartford, Conn. Catalogue of Veeder products, comprising odometers for automobiles, tachodometer (a speed indicator or tacometer combined with an odometer) odometers for carriages, cyclometers, revolution counters, speed counters, mileage recorders for elevators, and die-castings.

NATIONAL-ACME MFG. Co., Cleveland, Ohio. Booklet on the adjustable screw-cutting spring dies which are carried in stock by the company. The advantages of spring dies are enumerated, as are also the special advantages of the "Namco" form, which are perfect rake and clearance for the teeth, ample chip room and correct temper.

CELFOR TOOL Co., Buchanan, Ill., Catalogue No. 11 on drills, reamers, flue-cutters, countersinks, chucks, sockets, tool-holders, tool-bits, and boring tools. The catalogue concludes with a table of feeds and speeds for cast iron, medium steel and hard or very tough steel, and a table of decimal equivalents comprising both English and metric measure up to 76 millimeters and 3 inches.

PERMANENT MANUFACTURERS EXHIBIT RAILWAY SUPPLIES AND EQUIPMENT, Karpen Bldg., 900 S. Michigan Blvd., Chicago. Pamphlet on scope and purpose, exhibition hall and equipment, division and allotment of space, power for working machinery, character of exhibits, and other matters of interest to manufacturers desiring to reach the buyers of railway supplies. The exhibition opened March 16.

NORTON Co., Worcester, Mass. February number of *Grits and Grinds* containing an account of the award of the *Scientific American* medal to the Norton Co. for grinding-wheel protective devices, description of the American Museum of Safety, New York, and an article on the safety movement in America and abroad. The protection hoods for grinding wheels made by the Norton Co. are also illustrated and described.

PEERLESS RUBBER MFG. Co., 16 Warren St., New York. Catalogue No. 100 of mechanical rubber goods comprising "Rainbow" sheet packings, "Peerless" piston and valve rod packings, combination packing, gaskets, rubber belting, elevator and conveyor belts, water and steam hose, air-brake hose, pneumatic tool hose, acid hose, pump valves, car vestibule diaphragms, gas engine bags, rubber cement, rubber matting, sheet rubber tiling, etc.

UNITED STATES BUREAU OF MINES has just issued Technical Paper No. 8, by Frederick M. Stanton and Arno C. Fieldner, in order to suppy the constantly increasing demands for information relating to the methods used by the Bureau of Mines in analyzing coal and coke. This technical paper describes the methods in use at the laboratories of the bureau for analyzing coal and coke and determining the heating value of these fuels. Copies may be obtained by writing to the Director of the Bureau of Mines, Washington, D. C.

HEALD MACHINE Co., 20 New Bond St., Worcester, Mass. Booklet giving the personnel of the company and its history. The business of the Heald Machine Co. was established by Stephen Heald in the year 1830, in Barre, Mass., and at first comprised the making of woodworking machinery and agricultural implements. In 1903 Mr. James N. Heald bought out his father's interest and moved the plant to Worcester, where it was organized under the name of Heald Machine Co. The plant now covers 50,000 square feet and employs 160 persons.

TAFT-PEIRCE MFG. Co., Woonsocket, R. I. Illustrated booklet showing the various departments and equipment of the plant, which is one of the largest and finest in the world devoted exclusively to the handling of light high-grade machine work on the contract basis. The company specializes on making equipment for manufacturing, comprising jigs, fixtures, dies, tools, etc., required for the economical manufacture of interchangeable machine parts. The toolroom equipment illustrated is without parallel in the United States. The booklet will be found of unusual interest to all concerned with toolmaking and high-grade machine production.

WESTINGHOUSE ELECTRIC & MFG. Co., E. Pittsburg, Pa. Special publication R. L. 57, entitled "Synchronous Motors for Power Factor Correction." This booklet, which has an art cover, contains some of the most valuable common-sense data on the phenomena of power factor and on the bad effects of low power factor and power factor correction with synchronous motors, that has been published. The publication gives much more specific data on synchronous motor installations, including curves and diagrams by means of which anyone can determine, with a few simple calculations, the capacity of a synchronous motor necessary to corrrect a given load from and to given power factors. The booklet is sent free to any address on request.

LUCAS MACHINE TOOL Co., Cleveland, Ohio. Circular of new model No. 33 precision horizontal boring, drilling and milling machine; and leaflet on the vertical milling attachment which is now furnished for the Nos. 32 and 33 machines. The No. 33 machine, like the intermediate model No. 32, has constant-speed quick power movements to all parts, having feeds so arranged that no matter what feed is used the quick return for that feed is obtained by simply moving the feed and quick-return lever in the reverse direction. The vertical milling attachment is of the bridge form of construction with both ends supported and rigidly tied by the uprights. The attachment can be quickly removed, leaving the machine unencumbered for use as a regular horizontal boring and milling machine.

J. T. SLOCOMB, Providence, R. I. Catalogue No. 13 of machinists' tools, comprising external micrometers up to 18 inches capacity, internal micrometers, standard end measures, standard reference disks, screw thread micrometers, special micrometers, centering tools, combination center drills, etc. The new catalogue is bound in a red waterproof cover, printed in black and gold. The size is 5⅞ by 7⅝ inches, which is more convenient for the pocket than the common catalogue size, 6 by 9 inches. The tools illustrated and listed are fully described, a feature that is appreciated by intending buyers. A number of valuable tables for machinists which apply particularly in the use of these tools is included. Copies of the new catalogue will be sent to any address upon receipt of request.

GEOMETRIC TOOL Co., New Haven, Conn. Book entitled "Special Threading Tools," illustrating and describing the "Geometric" screw cutting die heads of the self-opening and adjustable type made in styles D, C, and DD; "Geometric" solid adjustable die head for use on automatic screw machines where the direction of rotation of the piece is reversed on the completion of the thread; "Geometric" adjustable collapsing taps; "Geometric" adjustable hollow milling tools; "Geometric" chaser or die grinder; "Geometric threading machine." The book is virtually a treatise on the special threading tools, showing their form and component parts with fine halftone views, and giving valuable information for users of modern threading equipment. It contains several pages of valuable data useful to makers of bolts, screws, nuts and other threaded work.

DODGE MFG. Co., Mishawaka, Ind. Catalogue C-12 containing 413 pages, beautifully illustrated and printed, is being distributed to the trade. The first pages are devoted to interior views of Dodge foundries, machine shops, power plant and branch houses; then follow tables for laying out shafting, horsepower of steel shafting, dimensions, etc. Every product of the company—a complete line of power transmission machinery and appliances, elevating and conveying equipment, rope driving system, and water softener apparatus—is completely described and listed. Considerable space is devoted to the Dodge friction clutch as an accident prevention device. The concluding pages give a little history of the transmission of power by Manila rope with illustrations of a number of striking installations, heavy engineering work, etc. The business was established in 1878 by Wallace H. Dodge, inventor of the split wood pulley with interchangeable bushings which effected a revolution in the pulley art. At that time, the plant occupied only a few acres of ground in Mishawaka. To-day there are 63 acres of ground space and over 21 acres of floor space.

TRADE NOTES

DOEHLER DIE-CASTING Co., Court & 9th Sts., Brooklyn, N. Y., is about to erect a reinforced concrete addition to its present plant, consisting of seven floors, 50 by 100 feet.

LANSING Co., Lansing, Mich., recently purchased the entire hoist building plant of the Butcher & Gage Co., Jackson, Mich., and in the future will manufacture the Wolverine contractors' hoist in Lansing.

FAVOR, RUHL & Co., 49 Barclay St., New York, have taken the sales agency for the "Tec" line of drafting-room supplies for New York City and vicinity, controlled by the Technical Supply Co., Scranton, Pa.

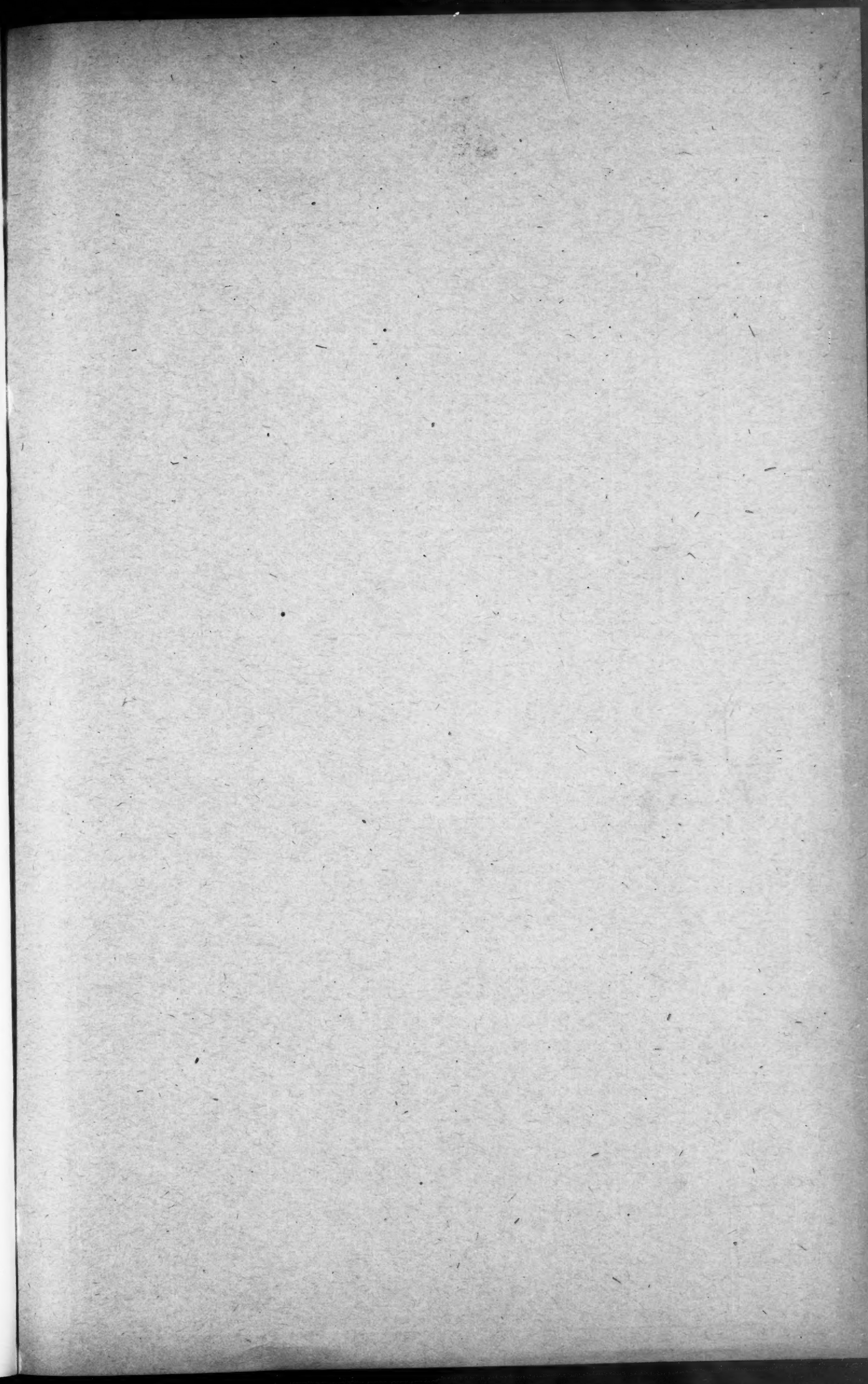
EDGAR ALLEN & Co., LTD., 86 John St., New York, agents for Allen's high-grade tool steel are now located at the foregoing address. A complete stock of steel is carried, and all requirements of customers can be promptly met.

HAUCK MFG. Co., 149 Livingston St., Brooklyn, N. Y., had a small fire in the office March 5. The fire destroyed some furniture, unimportant records and papers, but in no way affected the manufacturing facilities. There will be no delay in handling orders.

METALLIC SHELL & TUBE Co., has removed from Pawtucket, R. I., to a large three-story building at 129 Valley St., East Providence, R. I. The change of quarters was made necessary by the rapidly increasing growth of the business. The company is installing new machines and equipment, and will be in a better position than ever to take care of seamless tube wants.

BLOOD BROS. MACHINE Co., Kalamazoo, Mich., manufacturer of universal joints, is running its factory with full force night and day. Although new buildings and equipment have been added during the past four months, nearly doubling the original capacity, the company is still barely able to keep up with orders. The entire factory is at present devoted to the manufacture of universal joints.

PARKER TRANSMISSION & APPLIANCE Co., has moved from Springfield, Mass., to Fulton, N. Y., where it will continue the manufacture of the Parker "all-in-mesh" transmission gears for automobiles. The company will also develop several of Mr. Parker's inventions. The capitalization was recently increased from $250,000 to $1,000,000, and plans have been made for pushing the business aggressively.

E. L. ESSLEY MACHINERY Co., Chicago, Ill., had a fire in its store at 555-557 Washington Blvd., March 7, which completely destroyed its office records. The large warehouse, 817 Washington Blvd., containing 10,000 square feet of floor space was untouched by the fire however, and the company's offices are temporarily located at this address. The warehouse is filled with new and second-hand machinery, and the fire will not seriously interrupt the business.

JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J., has just put on the market a new chain graphite, especially intended for lubricating the chains of motor trucks and pleasure cars. This preparation is put up in cylindrical sticks, 2 by 8 inches, encased in a neat cardboard carton and weighing about one pound each. This convenient chain lubricant can be carried ready for use at any time, and is simply applied by rubbing the bar against the sprocket side of the chain. Unlike oils and greases, graphite does not rapidly collect dust and dirt.